

Forest Health Conditions in Wisconsin



Annual Report 2006

Compiled and Edited by

Division of Forestry

Forest Health Protection Staff

Wisconsin Dept. of Natural Resources

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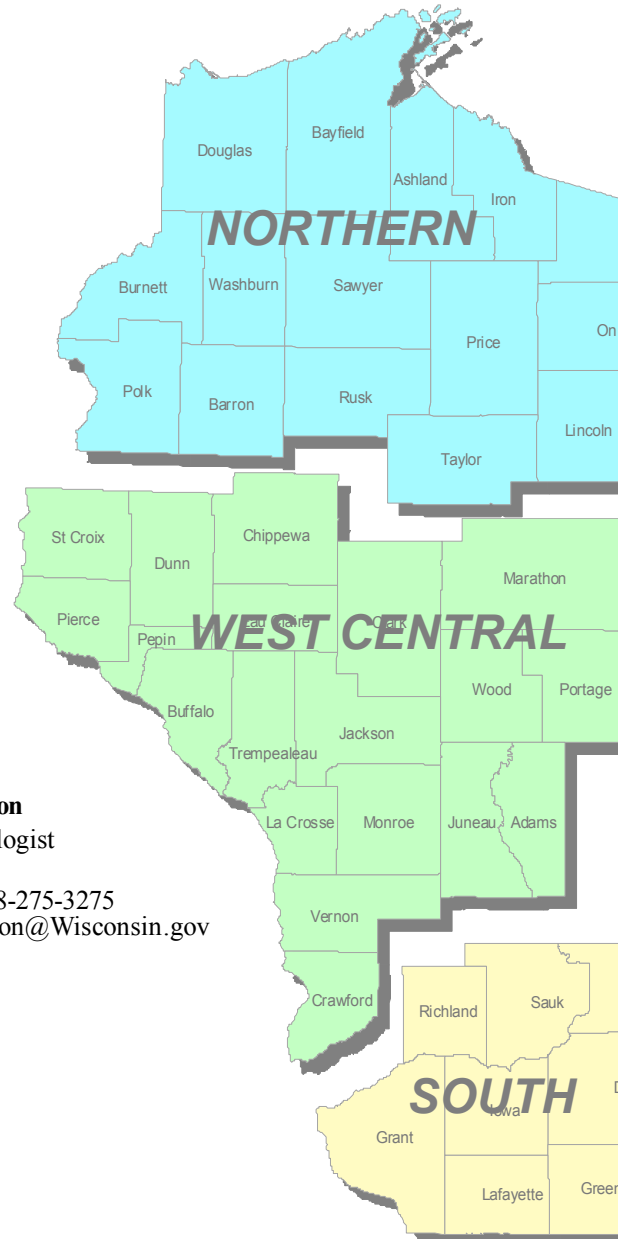
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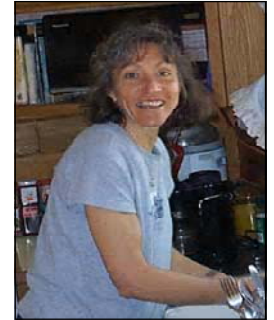
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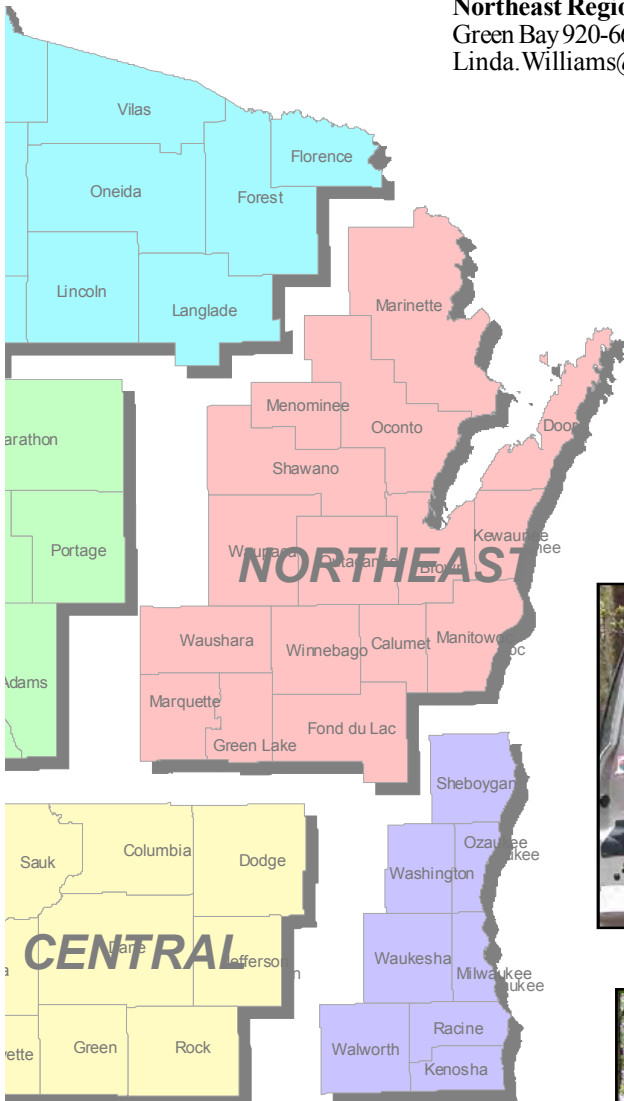
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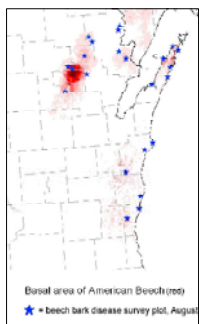


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Alerts

Emerald Ash Borer

See Major Issues Section for information on Emerald Ash Borer

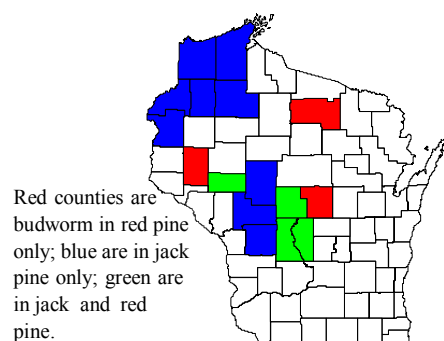


Beech Bark Disease

Twenty-three early detection plots, established in eight counties were all negative for the presence of Beech Bark Disease. Survey sites have been established on state, county, city, or private land. Survey sites were chosen where the incidence of beech and probability of human transport of infested wood were highest. A minimum of 30 trees at each site were examined for the presence of the scale (*Cryptococcus fagisuga*) that is found at the advancing front of this disease.

Jack Pine Budworm

As the population of this insect (*Choristoneura pinus pinus*) declines in northwest Wisconsin, focus on jack pine budworm has turned to the developing population on red pine in west-central Wisconsin. Since 2004, the budworm has been observed feeding and completing its life cycle on 14 – 35+ year-old red pine. By 2006, budworm had been observed feeding on red pine in 7 counties. A 2-year research project will be initiated in 2007 to study the impact of budworm on red pine and determine what factors have influenced this change in feeding patterns.



Hickory decline/mortality

Dieback and mortality on hickory continued to be a problem in southern and central Wisconsin in 2006. Mortality was seen both on bitternut and shagbark hickory. The symptoms progress from thinning crowns to branch mortality to complete tree mortality. Epicormic branches often sprout from the main stem only to wilt and die later.

Historically, research has found hickory mortality to be associated with attacks by the hickory bark beetle (*Scolytus quadrispinosus*) following periods of drought. More recent research, however, suggests that two recently named fungi, *Ceratocystis caryae* and *C. smalleyi*, could cause canker and limited wilt disease in hickory. At this point, little is known about the relative role of these fungi and their distribution in Wisconsin.

In the summer of 2006, the USDA Forest Service conducted a survey to detect the presence of *Ceratocystis* spp. on declining hickory trees in Wisconsin and some neighboring states. Wood samples were collected from 8 stands throughout Wisconsin where hickory dieback and mortality have been observed. Eighteen isolates of *C. smalleyi* and/or *C. caryae* were obtained from 6 of the 8 stands sampled. Species identification of these isolates is in progress by Dr. T.C. Harrington from Iowa State University. The USDA Forest Service plans additional field evaluations to determine relationships between hickory decline/mortality and stand and landscape level factors, provided additional funding. Furthermore, this project will investigate the role of *Ceratocystis* spp. and other fungi in the decline and mortality process.

Sirex Wood Wasp

Sirex woodwasp (*Sirex noctilio*) native to Europe, Asia, and northern Africa, is generally considered to be a secondary pest in its native range where it attacks pines including Scotch (*Pinus sylvestris*), Austrian (*P. nigra*), and maritime (*P. pinaster*) pines. The impact of Sirex woodwasp on Wisconsin's *Pinus* spp. is unknown but is likely to cause mortality of pines that are stressed by being overstocked or subjected to drought. All *Pinus* spp. are considered susceptible. Sirex woodwasp was first detected in the United States in 2004 when a specimen was trapped in New York state. The insect is currently known to be in New York and southern Ontario, Canada. Trees infested with Sirex woodwasp are killed by a fungus, *Amylostereum aerolatum*, which is introduced by the woodwasp and disrupts the vascular system. Wisconsin is currently considered low risk for establishment of and susceptibility to this insect but high risk for introduction in or near Milwaukee and Green Bay. See minor issue section for more information on Sirex survey activities in Wisconsin.

Link to more information on Sirex Woodwasp

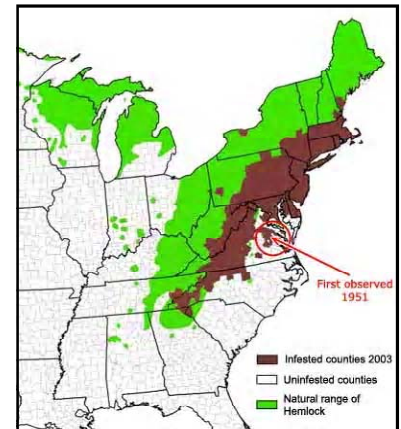
http://www.na.fs.fed.us/spfo/pubs/pest_al/sirex_woodwasp/sirex_woodwasp.pdf

Hemlock Woolly Adelgid

Hemlock woolly adelgid (*Adelges tsugae*), native to Asia, is a sap-feeding insect that infests hemlock, causing stress and tree mortality, particularly when drought or defoliation is also occurring. Hemlock woolly adelgid arrived in the eastern US around 1950 and is now present in several eastern states (see map). On Aug. 21, hemlock woolly adelgid was found on hemlock trees planted in the Harbor Springs area (near Petosky) in Emmet County Michigan. The trees had been imported in 2003 from a nursery in West Virginia. The Michigan Department of Agriculture and Department of Natural Resources have conducted an intensive survey of the area and are attempting to eradicate or significantly reduce the population through a combination of removals and chemical sprays.

For more information on this topic visit:

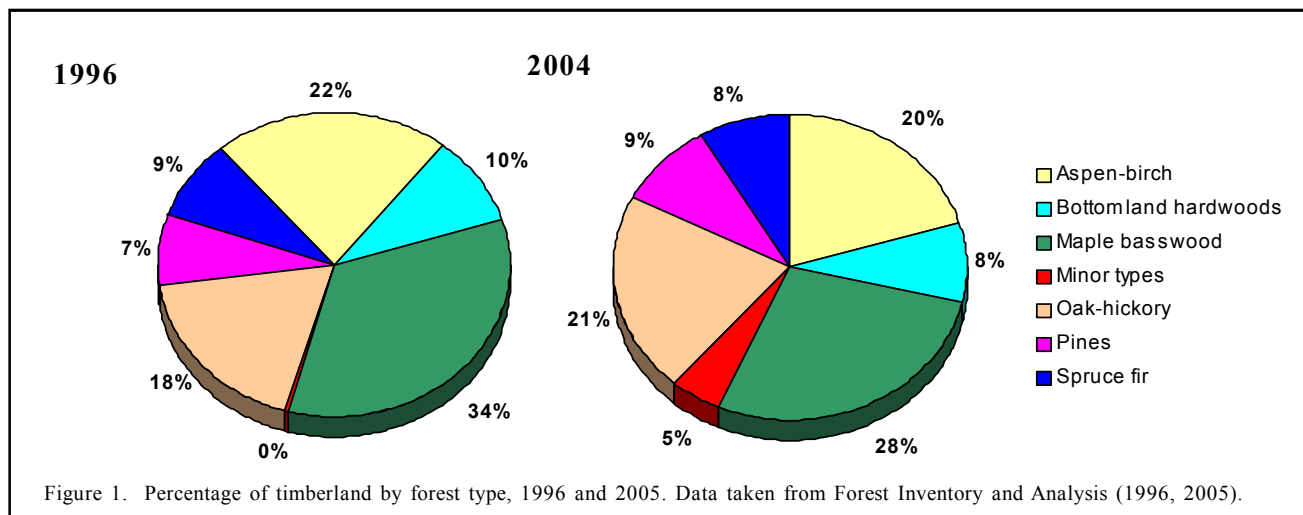
http://na.fs.fed.us/spfo/pubs/pest_al/hemlock/hwa_05.pdf



Native range of hemlock (green) and range of hemlock woolly adelgid (brown) in 2003.

Proportion of Forest Land and Timberland

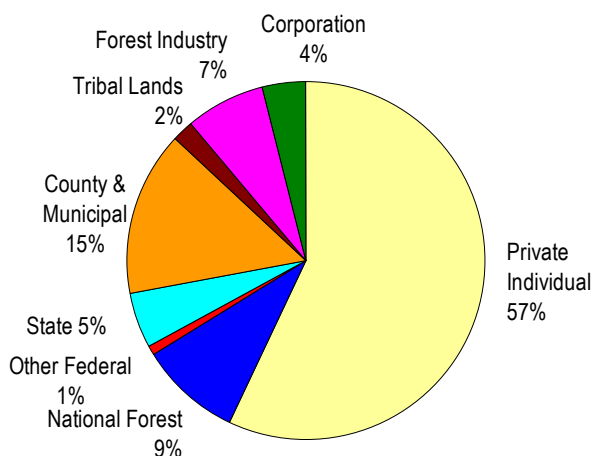
—The area of forestland in Wisconsin has been steadily increasing in recent decades and currently stands at c.15.9 million acres, representing 46% of the total land area. This is an increase of over 1.1 million acres since 1983. The



state now has the most forest land it has ever had at any time since the first forest inventory in 1936. Wisconsin's forests are predominately hardwoods, with 78% (Figure 1) of the total timberland area classified as hardwood forest types. The primary hardwood forest type in the state has changed from the 1930's when aspen-birch comprised 40% of timberland. As our forests have aged, these types which dominated on cut-over land have been replaced by later successional species such as maple-basswood and oak-hickory which account for 49% of timberland acreage. (Timberland is defined as forest land that is producing, or is capable of producing, more than 20 cubic feet per acre per year of industrial wood crops under natural conditions.)

Ownership of Wisconsin's Timberland

—Individual private landowners are the largest group of timberland owners in Wisconsin, owning 57% of all timberland in 1996 (Figure 2). Counties and municipalities are the largest group of public owners, holding 15% of the total area of timberland in Wisconsin. The public owns a total of 30% of all timberland. The percentages of ownership have remained relatively constant since the forest inventory in 1956.



Growing-stock Volume of Wisconsin's Timberland

—Growing-stock volume on timberland in Wisconsin increased from 15.5 billion cubic feet in 1996 to 19.7 billion cubic feet in 2004, reflecting an increase in both area and stocking between inventories. In both 1983 and 1996, hardwoods

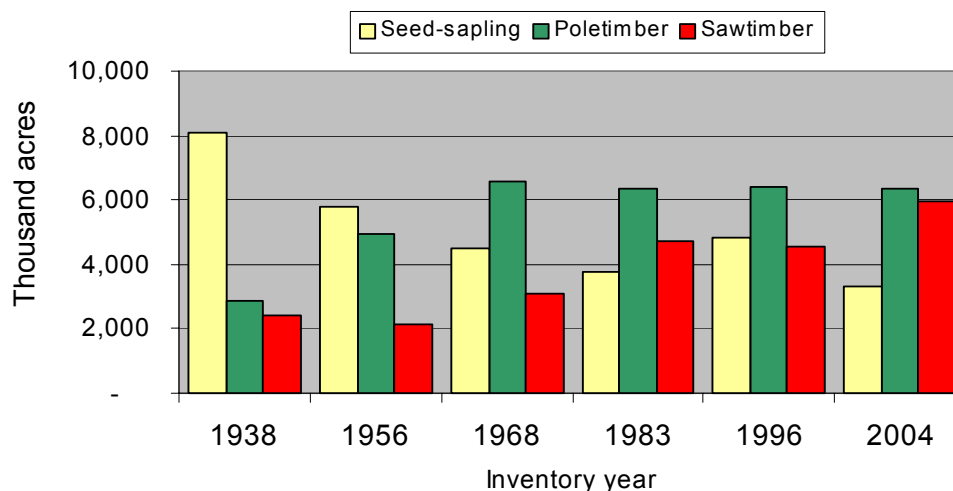


Figure 3. Acreage by size class on timberland in Wisconsin, 1938-2004. Data taken from USDA Forest Inventory and Analysis.

accounted for $\frac{3}{4}$ of all growing-stock volume. Acreage in seedling-sapling stands had been decreasing and acreage in sawtimber stands had been increasing since 1938 reflecting the natural aging of forests since the turn of the century. (Figure 3). Acreage in sawtimber has increased from 28% to 38% of total acreage since 1996, amounting to 1.5 million more acres of older stands with larger trees.

Most Common Species Groups of Wisconsin's Timberland

Although aspen accounted for the largest species group in 1996, white and red pine had the highest growing stock volume in 2004. Other species which have gained between the 2 inventories are red maple, pin oak, and ash spp. while volumes of aspen, red oak and jack pine have declined.

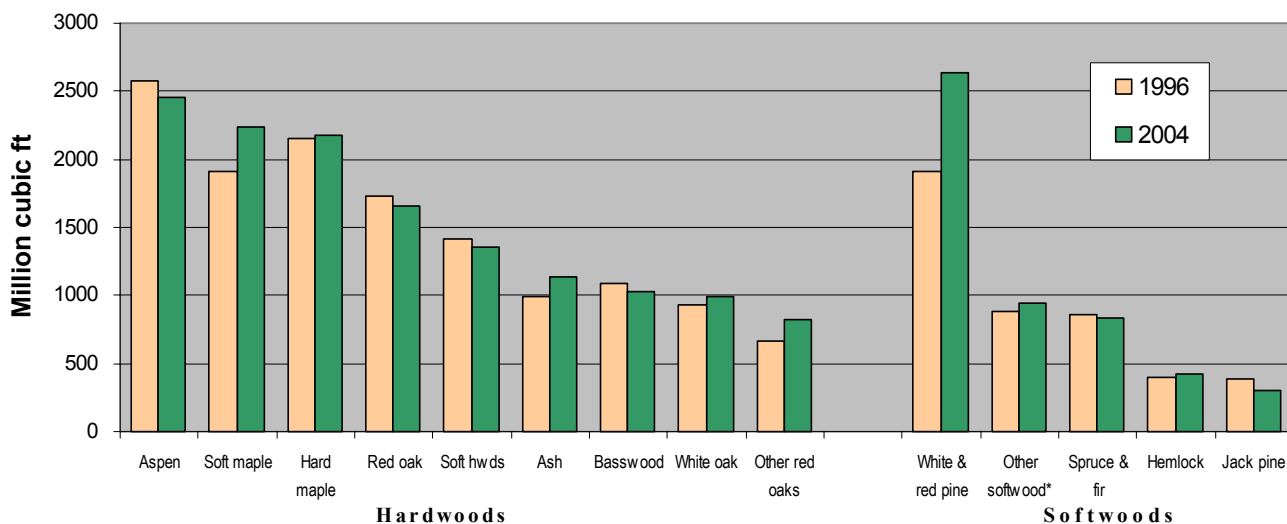


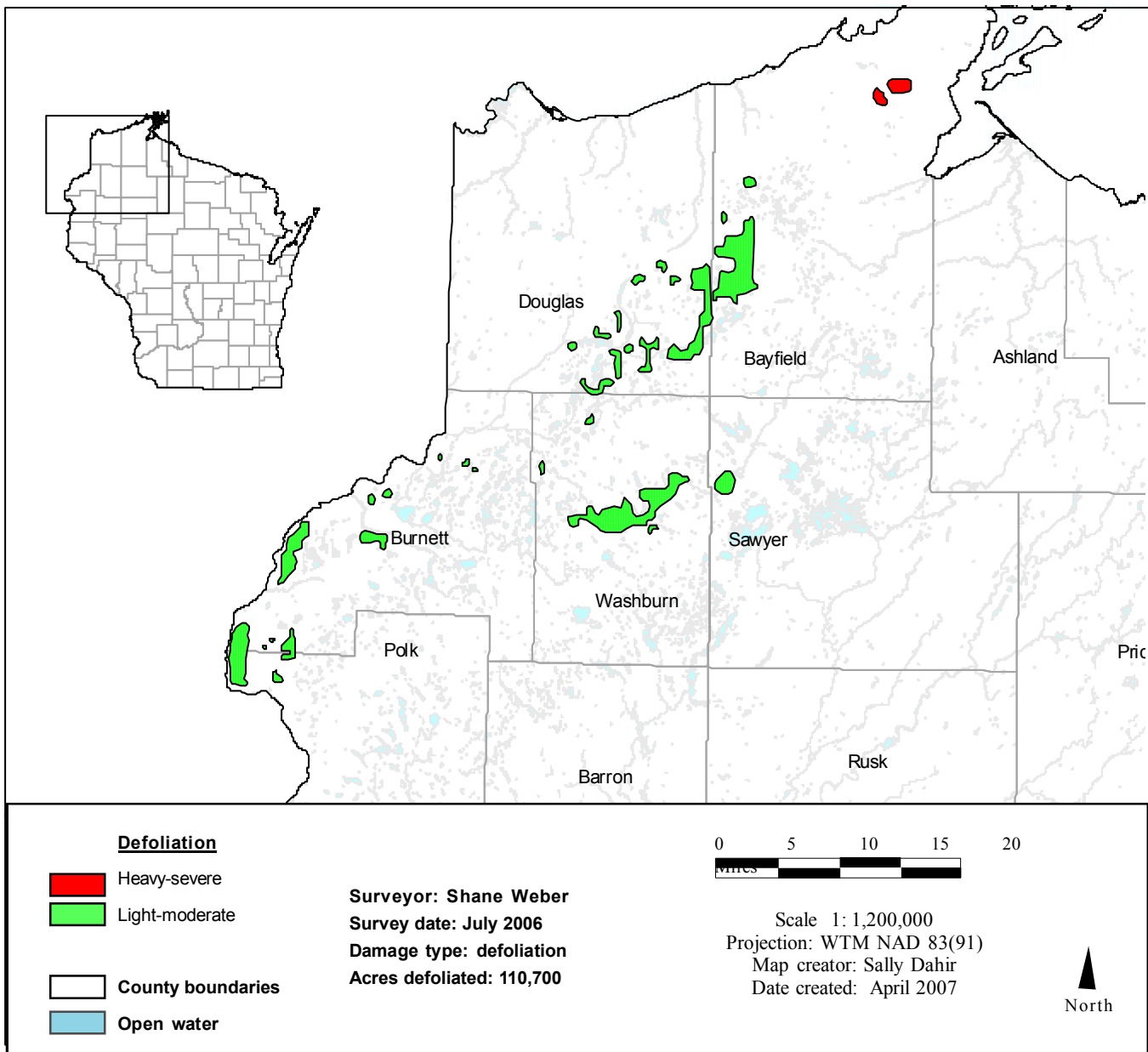
Figure 4. Most common hardwood and conifer species (in million cubic feet of growing stock volume) on timberland in Wisconsin in 1996 and 2004 (taken from Forest Inventory and Analysis data). Soft hardwoods include elm spp., boxelder, birch spp., and hackberry. Other softwoods include red and white cedar and tamarack.

Major Issues

Jack Pine Budworm

Northwestern Wisconsin

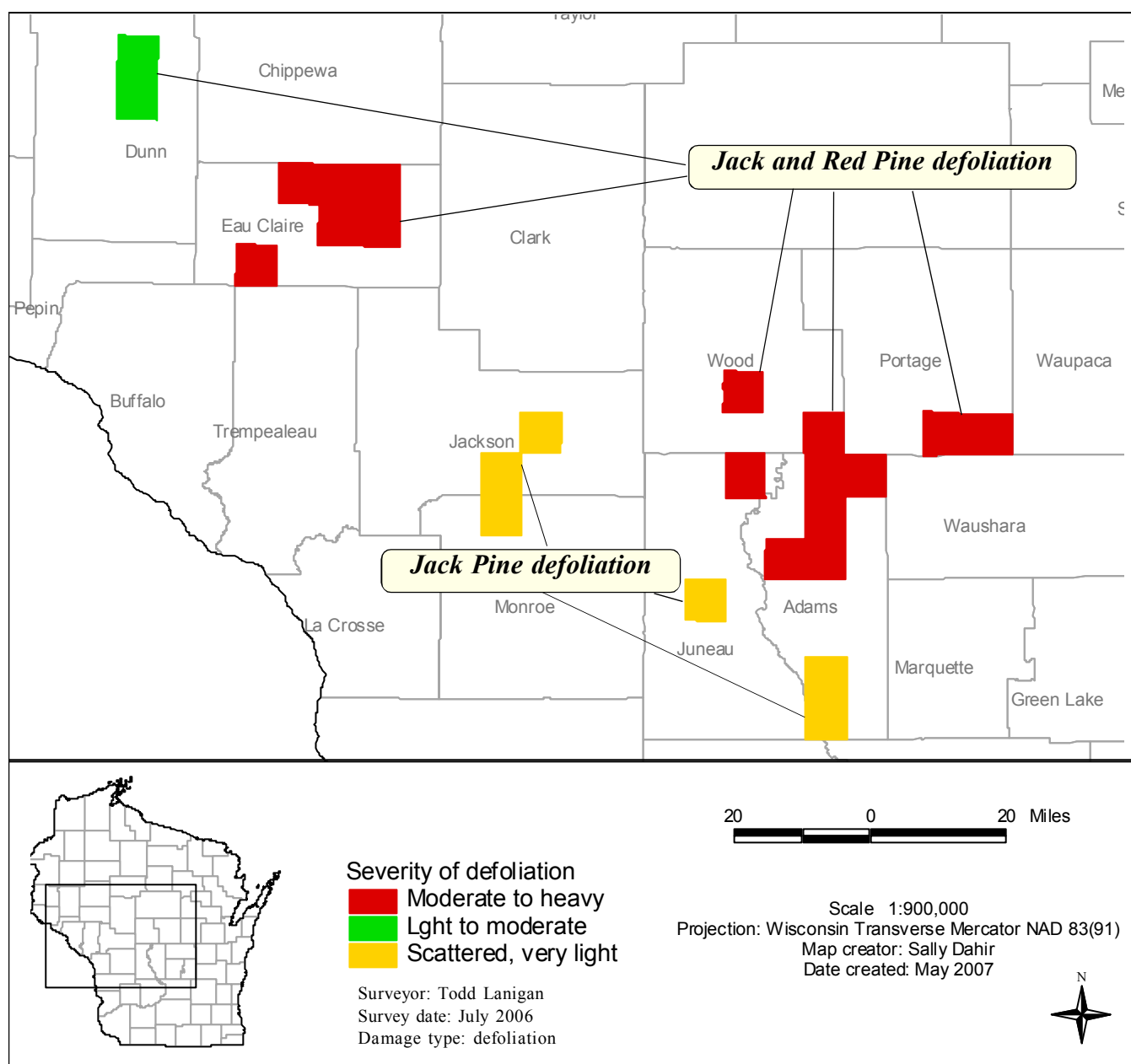
The population of jack pine budworm (*Choristoneura pinus pinus* Freeman) dropped significantly in northwestern Wisconsin in 2006 but was on the rise in west-central Wisconsin. The only area in northwestern Wisconsin that experienced heavy to severe defoliation was 3,000 acres in Bell and Bayview townships, Bayfield County. Polk, Burnett, Washburn, Douglas, and Sawyer counties suffered only moderate levels of defoliation. The total number of acres defoliated in northwest Wisconsin in 2006 was 110,700, compared to 222,500 acres in 2005. Pupal surveys indicate a continued decline for jack pine budworm in northwestern Wisconsin in 2007.



West-central Wisconsin

Jack pine budworm has preferred jack pine as its favorite host as long as forest health specialists have been monitoring Wisconsin's populations (1959) and has only been occasionally found feeding on red pine. Yet during the late summer/early fall of 2004, defoliation was observed in a 20-30-year-old red pine plantation in Adams County. Entomologists have thought this insect would not complete its life cycle on red pine because the needles of red pine are too thin for the female to lay her eggs on the needle surface. In 2004, the budworm successfully laid egg masses on red pine needles.

In 2005, jack pine budworm expanded into more red pine plantations in Adams County; both young (20-30-year-old) plantations and older (35+ year-old) plantations were affected. Jack pine budworm was also found in young (20-30-year-old) red pine plantations in Eau Claire, Juneau, and Wood counties.



In 2006, jack pine budworm was observed defoliating red and jack pine in Adams, Eau Claire, Juneau, and Wood counties; defoliation of jack pine only was observed in Jackson and Monroe counties. In Juneau County, budworm was found in a red pine plantation that was planted in 1996. Budworm was discovered for the first time defoliating young red pine plantations (14-30 year old) in Dunn and Portage counties. The pattern of defoliation in these young stands was very typical of jack pine budworm with feeding starting at the top and continuing down the crown. Open grown trees usually have more defoliation than trees inside the plantation. Typical top dieback and mortality is occurring in these red pine plantations.

Defoliation in the 35+ year-old red pine plantations was very different from typical budworm feeding in the same age class of jack pine. In red pine, budworm feeds on an individual tree, causing heavy defoliation; the surrounding trees will have light to moderate levels of needle loss. This pattern is scattered throughout the red pine plantation. In jack pine, trees throughout the stand will be defoliated, with a few nonaffected trees scattered throughout the stand.

Pine bark beetles, red turpentine beetles, and pine sawyers can be found in the defoliated red pine plantations. Jack pine budworm appears to be thriving on red pine and the population shows no signs of decline at this time.



Jack pine budworm feeding on red pine

A request for funding to partner with entomologists at the University of Wisconsin Stevens Point and Madison has been submitted to the USDA Forest Service. If funded, a 2-year investigation will be initiated.

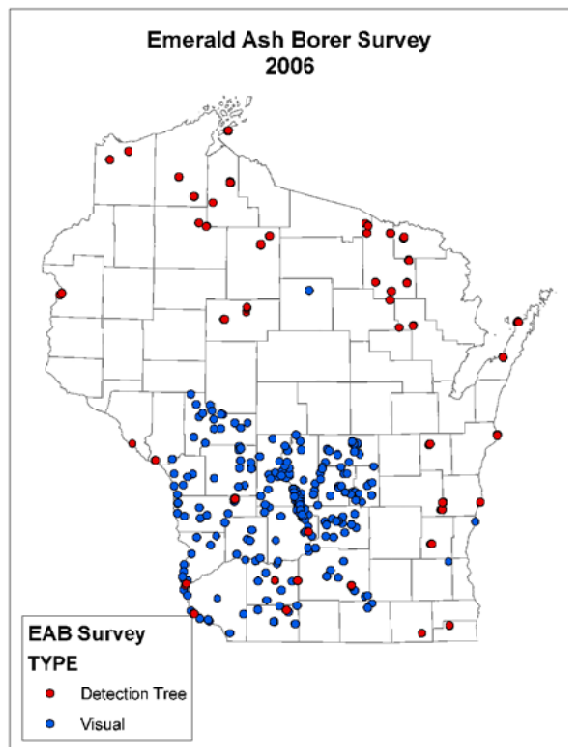
Emerald Ash Borer

Wisconsin Department of Natural Resources (DNR) Survey Summary (detection and visual)

The DNR has completed a third year of surveying for emerald ash borer. In an effort to detect EAB before the infestation becomes widespread in Wisconsin, the DNR has continued to conduct both detection-tree and visual surveys throughout the state. Detection trees (girdled ash trees with a band of tangle trap above the girdle) established on state forest properties along the Lower Wisconsin Riverway (LWRW) in 2005 were felled and peeled during 2006. Seven detection trees were monitored along a 23 mile stretch of the LWRW between Mazomanie Beach in Dane County (latitude N 43.23463°, W -89.80737°) and Long Island in Richland County (N 43.16723°, W -90.19702°). In November, detection trees were felled and the bark peeled to look for developing emerald ash borer larvae or their serpentine galleries in the cambium layer. No emerald ash borer larvae were detected during bark peeling. However, other larvae identified during the bark peeling included one undetermined species of metallic wood-boring beetle (not emerald ash borer), and a long-horned beetle species. In addition, ash bark beetle and ash cambium miner



Detection tree



galleries were evident in the cambium layer and red-headed ash borer galleries were detected in the sapwood.

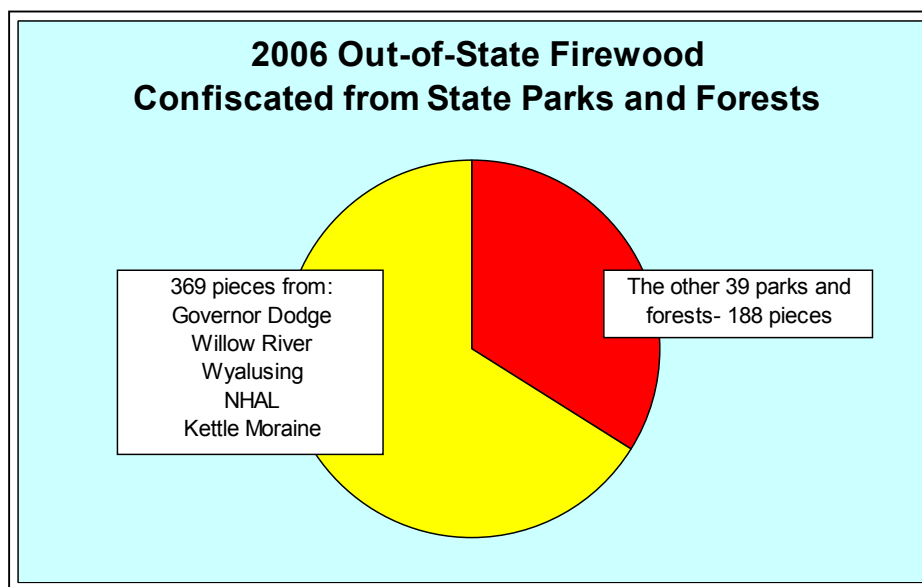
Visual surveys were also conducted at 235 private and county campgrounds and recreational areas throughout South central and Southwestern Wisconsin. More than 24,000 campsites were visited, while surveying more than 3500 ash trees. These surveys resulted in finding no emerald ash borers. However, there were 18 suspect trees which were determined to need follow-up surveys due to the presence of a combination of three or more emerald ash borer-like symptoms (branch dieback, epicormic sprouting, woodpecker feeding, yellow foliage, bark cracks). The overall health of the ash trees surveyed was good, with only minor insect and disease findings such as ash plant bug, ashleaf gall mite, ash flower gall mite and the leaf disease anthracnose. More serious health issues were few, but did include signs of drought stress and ash yellows.

WI DNR Emerald Ash Borer detection tree locations and peel dates - 2006

Wisconsin State Parks	Trap Trees Set	Trees Peeled	Peel Date
Richard Bong SRA	6	3	10/2/2006
Big Foot Beach SP	7	3	10/2/2006
Yellowstone SP	5	1	10/3/2006
Nelson-Dewey SP	5	2	10/3/2006
Wyalusing SP	6	2	10/3/2006
Governor Dodge SP	7	3	10/6/2006
Blue Mound SP	7	3	10/2/2006
Lake Kegonsa SP	6	2	10/2/2006
Devil's Lake SP	8	4	10/4/2006
Wildcat Mountain SP	7	3	10/4/2006
Pike Lake CG (Kettle Moraine)	5	2	10/10/2006
Long Lake CG (Kettle Moraine)	7	3	10/10/2006
Mauthe Lake CG (Kettle Moraine)	7	3	10/10/2006
Kohler-Andrae SP	5	2	10/10/2006
High Cliff SP	7	3	10/10/2006
Point Beach SP	6	2	10/11/2006
Potawatomi SP	6	2	10/11/2006
Peninsula SP	6	2	10/11/2006
Merrik SP	5	2	10/4/2006
Interstate SP	7	3	10/5/2006
Perrot SP	6	3	10/4/2006
Pattison SP	6	2	10/24/2006
Big Bay SP	6	2	10/24/2006
Copper Falls SP	7	2	10/25/2006
Amnicon SP	5	2	10/26/2006
Total	155	61	

Emergency Administrative Rule for Firewood

A temporary rule on firewood restrictions went into place in spring of 2006. NR 45.04(1) (g) states, “On department lands, no person may possess firewood that originates from outside the borders of the state of Wisconsin. Firewood includes all wood, processed or unprocessed, meant for use in a campfire. The department may seize and dispose of firewood possessed in violation of this paragraph.” State Park and State Forest staff confiscated all firewood from out-of-state. Firewood was double-bagged, placed under a heavy tarp then either chipped or burned in late summer or fall.



Number of bundles of firewood confiscated in 2006.

Permanent Administrative Rule for Firewood

In August, 2006, the WI DNR Natural Resources Board passed a permanent rule to limit the distance firewood may be moved – when being brought onto DNR-owned properties.

SECTION 1. NR 45.04(1)(g) is created to read:

NR 45.04(1)(g) On department lands, no person may possess firewood that originates from greater than 50 miles from the campground on that property where the wood would be used, or the property itself if there is no campground, or from outside the borders of the state of Wisconsin. Firewood from sources approved by the Wisconsin Department of Agriculture, Trade and Consumer Protection is allowable. Firewood includes all wood, processed or unprocessed, meant for use in a campfire.

Public Education and Outreach Efforts

- Non-resident camper postcards: 20,000 mailed in early 2006 through Oct. 2006 to state park and state forest campers.
- Hunter postcards: 10,500 mailed to out-of-state hunters that came from EAB positive states.

- State Fair skyline display, literature.
- One page firewood reminder in the 2006 gun deer regulation booklet.
- Radio campaign in metro-Chicago area 2 days before Memorial Day and July 4th, on about a dozen stations playing multiple times/day.
- Multiple newspaper, radio, and TV interviews.
- Ad in WACO Annual Campground directory.
- State Park posters- Tri panel display.
- Produced a B-roll video package and distributed this to TV stations just before Memorial Day.
- Natural Resources magazine article- could be reprinted by other organizations also.
- Multiple EAB presentations to WI Woodland Owners Association, Society of American Foresters, Master Gardeners, and other interested groups.

Firewood Inspection

A two-day firewood blitz was held at travel centers in southern Wisconsin on Thursday and Friday, Nov. 16 and 17, 2006, just prior to the opening of the state's regular gun deer hunting season. DATCP and DNR staffed welcome centers near Beloit, Genoa City and Kenosha to hand out information, talk with hunters and other travelers about the problems of moving firewood over long distances and try to ensure that firewood isn't being moved into the state from federally quarantined areas in other states.



Firewood blitz site.

Silvicultural guidelines

The DNR forest health protection program worked with the DNR silviculture team to develop guidelines for woodland owners as to how to prepare their woodlands to minimize damage from EAB. The complete guidelines may be accessed at the following link: <http://dnr.wi.gov/org/land/forestry/fh/PDF/EABWIManagementGuidelines.pdf>

New web portal

Wisconsin launched a new EAB web portal, through which many resources related to the Emerald Ash Borer may be accessed. The address for this site is: <http://www.emeraldashborer.wi.gov>

Rating the risk of introduction and impact of oak wilt for Wisconsin's forests

Analyses of over-land disease spread in summer-fall,

July 15 – October 15

Shane Lishawa

Forest Health Technician

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Introduction

Oak wilt, a disease which affects the vascular system of susceptible oak species, is caused by the fungus *Ceratocystis fackearum*. The two most common dispersal pathways for the fungus are below-ground through the intra-tree vascular connections created by root grafting and over-land via insect vectors which move the fungus between infected and wounded trees. Preventing oak wilt over-land distribution is best achieved by pruning and cutting oak in late fall and winter during the dormancy period of the causal fungus, insect, and tree. Risk of over-land oak wilt infection has been shown to peak from mid-April through early to mid-July. As a result, pruning and cutting of red oaks in the spring is highly discouraged. Following early July, the risk of infection has been shown to significantly decrease. However there is still an observed, though not quantified, risk of cutting and pruning oak in the summer and early fall. The objective of this study is to determine the relative risk of over-land oak wilt infection associated with cutting oak in July through mid-October.

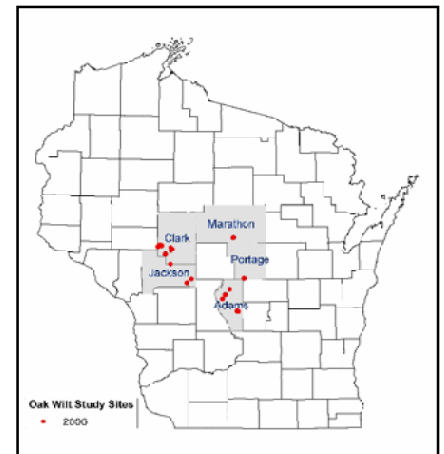


Figure 1. Oak wilt study sites in central Wisconsin for 2006.

Methods

Stands will be selected from the west central and central regions of Wisconsin. Topography in this region is generally flat to slightly rolling. To control for effects of topographic heterogeneity, stands with slopes greater than 20% will not be considered. Manipulated stands will have a scheduled thinning or timber stand improvement during one of three, month long time periods (table 1). Approximately 45 stands will be sampled in the study with 30 manipulated stands and 12-18 control stands. Additionally, $\frac{1}{2}$ of sites within each cutting period will have oak wilt present and $\frac{1}{2}$ will not have oak wilt (table 1). Seventeen stands were sampled in the summer of 2006, the first year of the study (Figure 1).



Figure 2. Study site design overlaid on an aerial image.

Study sites will be located within oak dominated stands a minimum of 10 acre in size. The size and shape of the sites will be evaluated using aerial photos in GIS prior to field visits. In late June through early July of the cutting

Table 1. Oak wilt study site selection criteria and temporal distribution

	Cutting Period	Oak wilt positive	Oak wilt Negative	Total
Manipulated	7/15 - 8/15	5	5	10
	8/15 - 9/15	5	5	10
	9/15 - 10/15	5	5	10
	Total	15	15	30
Control	7/15 - 8/15	2 or 3	2 or 3	4-6
	8/15 - 9/15	2 or 3	2 or 3	4-6
	9/15 - 10/15	2 or 3	2 or 3	4-6
	Total	6-9	6-9	12-18

year, basal area by species will be recorded for each study site (vegetation plots). Additionally, an exhaustive survey of all northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), and northern pin oak (*Quercus ellipsoidalis*) will be conducted to determine the presence and distribution of oak wilt in the study site (Figure 2). Oak wilt pockets will be identified, the GPS location will be recorded, and the bases of infested trees will be marked with red paint (Figure 3). Data from this portion of the study will be used to break selected stands into oak wilt positive and oak wilt negative groups, and to assess the extent of infection in oak wilt positive stands. Additionally, oak basal area will be used to determine if root grafting and below ground fungal movement is likely between trees. Following cutting in manipulated stands, all sites will be surveyed two or more additional times to determine the presence and distribution of oak wilt using the methods described above. New oak wilt infestations within 100ft of previously infested trees will be identified as possibly resulting from below ground fungal movement.



Figure 3. Oak wilt positive tree marked at the base with red paint

Initial post-cut sampling will occur in the early fall of the cutting year before leaf senescence, the second post-cut survey will occur in spring or early summer of the following year, and the third survey will be conducted during summer two years after cutting. Overall, four years will be budgeted for completion of the study. We will attempt to initiate the study on half of the sites in 2006 and half in 2007. A provisional time line is found below (table 2).

Table 2. Provisional time line of oak wilt study.

	Winter	Spring	Summer	Fall
2006	Site selection	Pre-cut survey	Cutting occurs	Post-cut survey
2007	Site selection	Pre-cut survey	Cutting occurs	Post-cut survey
2008			Post-cut survey	Post-cut survey
2009	Preliminary data analysis		Post-cut survey	Post-cut survey

Data will be analyzed to look for correlations between cutting period and new oak wilt infection in oak wilt positive and oak wilt negative stands. Additionally, the number of new oak wilt infections will be compared between control and experimental sites.

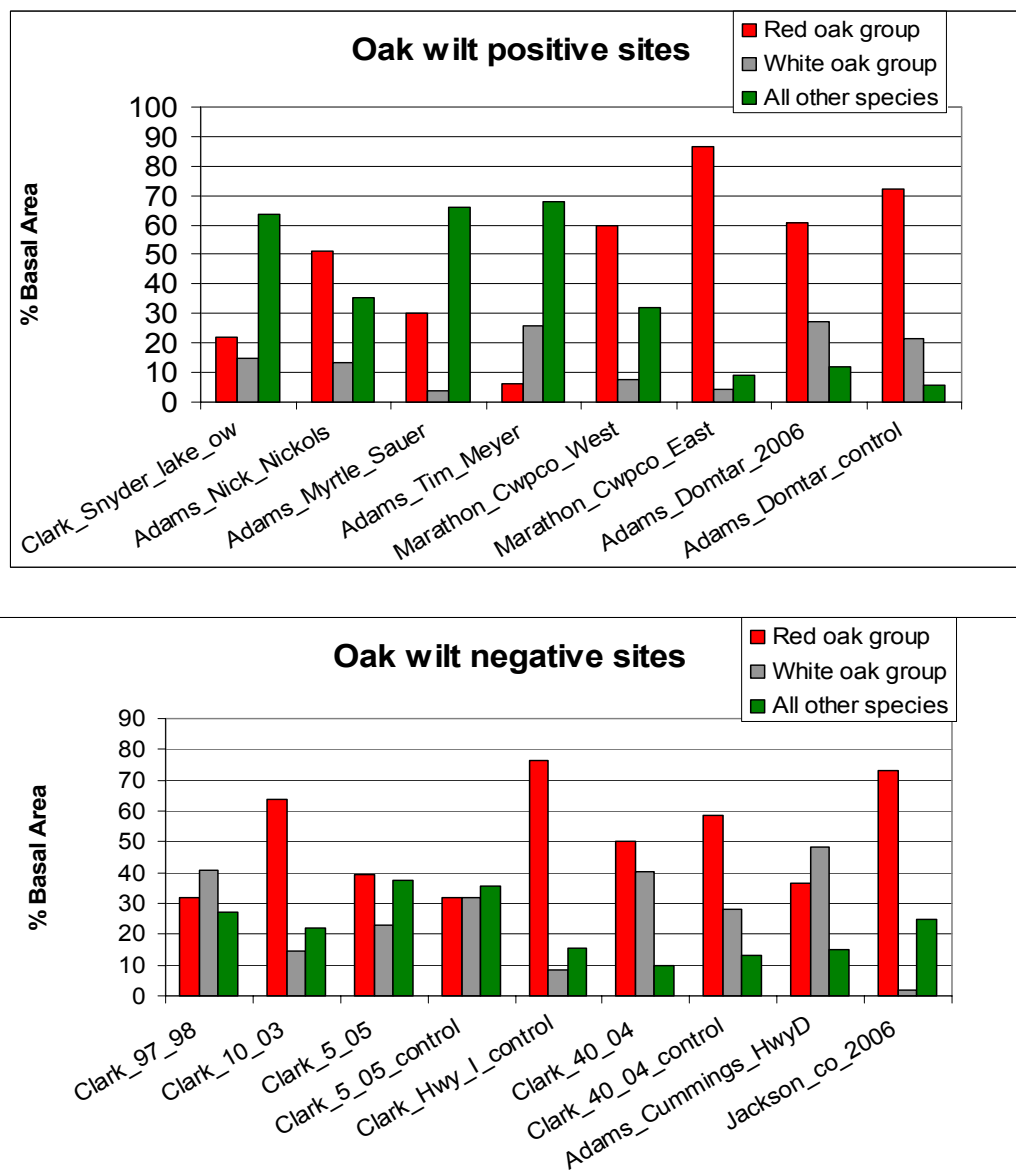


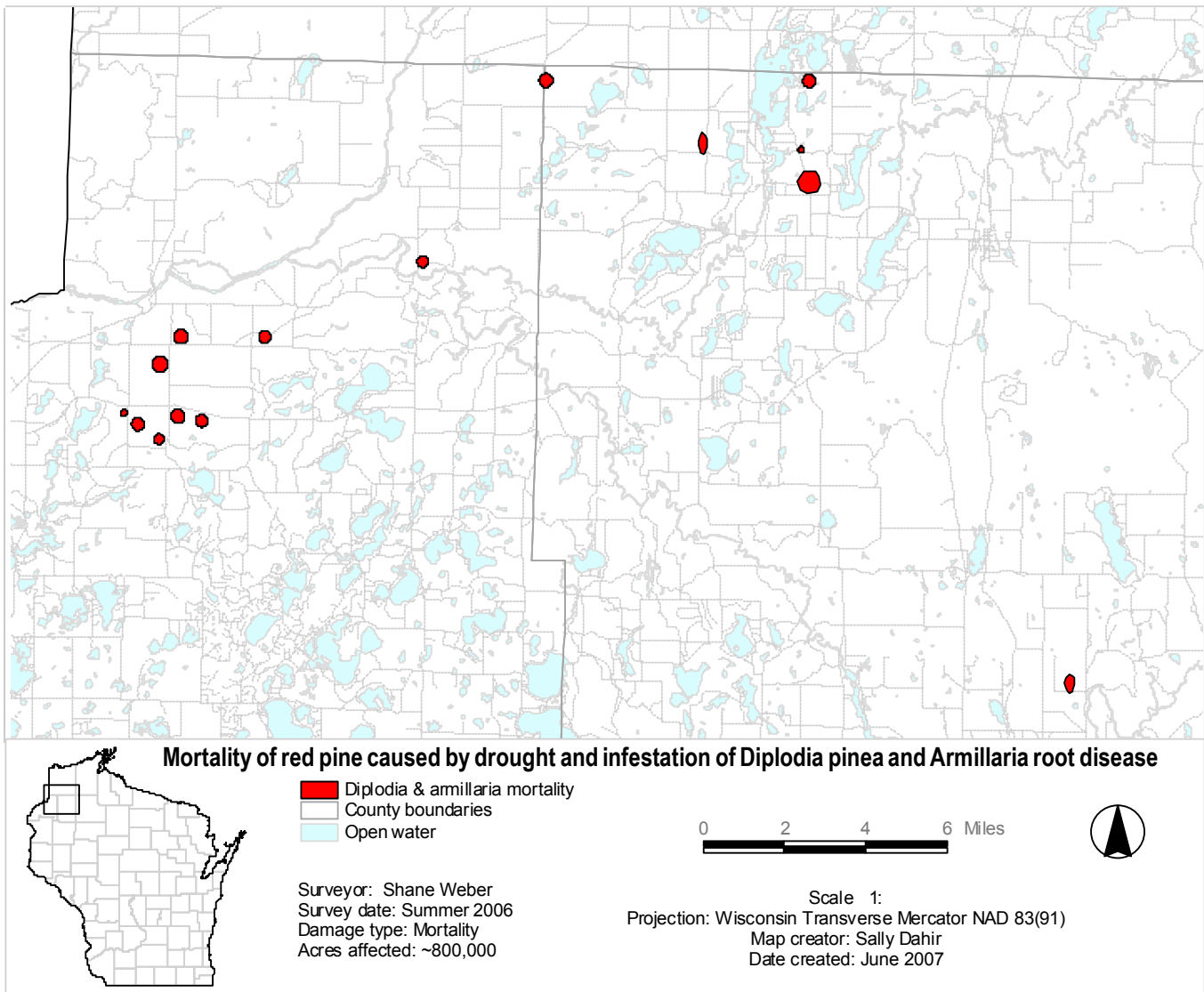
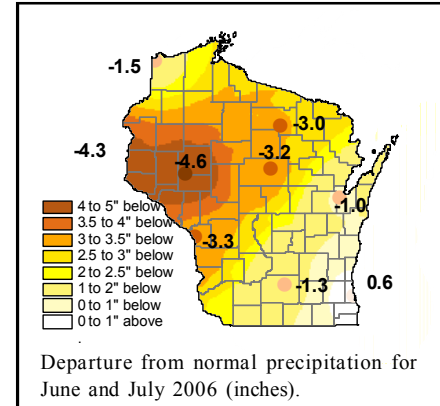
Figure 4. Percent basal area in three vegetation categories from 2006.

Results

Information gleaned from this study will be used to identify temporal oak wilt infection trends during the summer and early fall. This information will be used to establish precise relative risk categories for cutting oak in the summer and will thus provide important information to land managers and land owners who are interested in cutting and pruning red oak during the summer months. Data from vegetation sampling conducted in 2006 are displayed above (figure 4).

Drought-related *Diplodia* and *Armillaria*

Severe drought in northern Wisconsin during the growing season affected many species of trees but was most evident on the conifers. The injury from drought was amplified by the already drought-stressed status of the forests from low moisture levels in 2005. Red pine in northern Burnett and Washburn counties and southern Douglas county were killed by *Armillaria* root disease, *Diplodia* shoot blight and canker (caused by *Diplodia pinea*) and *Ips pini* bark beetles - all organisms associated with drought-stressed trees. As the summer progressed, red pine infested with *Ips pini* could be found throughout northwestern Wisconsin as the pine foliage faded from green to yellow to tan. Newly planted seedlings of many species were killed from lack of moisture. The two-lined chestnut borer, an *Agrilus* beetle that infests drought-stressed oak was also very active in northwest Wisconsin, killing oak on the driest sites. Drought-stressed balsam fir also experienced mortality as it was infected by *Armillaria* root disease and infested with balsam fir bark beetle. Early fall color, another symptom of drought stress was observed on white birch in northwestern Wisconsin.



Annosum Control Evaluation in the Sauk County Forest, 2006

Shane Lishawa

Forest Health Technician

Fitchburg WI

Introduction

Annosum root rot (*Heterobasidion annosum*) is one of the most common and destructive conifer plantation diseases in the northern hemisphere. The disease spreads above-ground through wind dispersed fungal spores that move from fruiting bodies onto the surface of freshly cut stumps and wounds. Additionally, annosum spreads below-ground between the roots of adjacent trees. Annosum was first discovered in Wisconsin in an Adams County red pine plantation in 1993 and it has since been found in 15 counties in the state (Fig. 1). In 2001, following an intensive survey of the Sauk County Forest, an annosum disease management trial was conducted involving silvicultural and biological control techniques. Visibly infected trees and the healthy trees within a 30' buffer zone around infection centers were harvested and residual stumps were treated with the fungus *Phlebiopsis gigantea*, an annosum biological control agent native to Wisconsin and commonly used in Europe. After five years, a follow up survey of the forest was conducted in order to evaluate the effectiveness of the disease management trial.

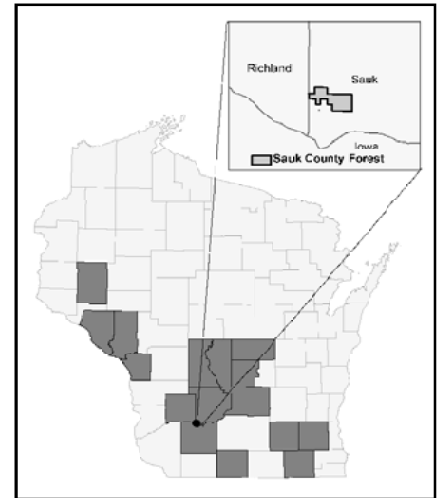


Figure 1. Wisconsin counties with confirmed Annosum in dark grey (January 2007) with an inset of the Sauk County Forest.

Methods

In the fall and winter of 2006-2007, pine plantations in the Sauk County Forest were systematically sampled in order to determine the presence and spatial pattern of annosum root rot and red pine pocket mortality (RPPM). First, the periphery of the annosum management trial pockets were examined for newly dead and dying trees. Dead trees or stumps with annosum fruiting bodies were spatially identified with a global positioning system (GPS) point (GARMIN GPSMAP 76). The remaining white pine, red pine, and mixed pine plantations were then examined for new pockets of dead and dying trees by walking transects through every fourth planted row. Newly identified pockets were flagged, marked with a GPS point, or demarcated with a GPS track. All GPS points and tracks were post-processed and evaluated for spatial accuracy in a geographic information system (GIS) by overlaying the map with 2005 aerial imagery. Trees were considered positive for annosum when fruiting bodies were identified (Fig. 2). Pockets of dying trees were considered positive for RPPM when signs of red turpentine beetle (*Dendroctonus valens*) and root collar weevil (*Hylobius radialis*) were present.



Figure 2. Annosum fruiting body at the base of a red pine.

Results

Of 17 annosum pockets where 30' buffer zones were created and stumps were treated with *P. gigantea* in 2001, annosum fruiting bodies were identified on newly dying and dead trees on the periphery of 8 pockets. Additionally, two new annosum pockets were discovered. Eleven RPPM sites were demarcated and nineteen new pockets with unidentified causal agents were marked (Fig. 3, 4).

Conclusions

Despite management efforts, annosum root rot has persisted on the periphery of nearly half of the managed pockets. There are two likely pathways for continued annosum presence in these sites. First, logging wounds or stumps treated with *P. gigantea* within the buffer zone may have become infected with *H. annosum* during the thinning and the fungus then traveled from the infected stump or tree to the newly infected trees via root contact. However, it is more likely that annosum spread underground via root contact from the original infection centers to the pocket periphery. If so, an estimated rate of below ground disease spread, the first in the northern United States, can be calculated from this data. In 5.5 years the pathogen spread approximately 30 feet resulting in a spread rate of 5.45ft/year. This rate of spread is an overestimate, however, if new above ground infections were initiated during thinning. A study examining the rate of *H. annosum* spread in an un-thinned stand is necessary to control for potential above-ground disease movement and to further test below-ground spread rate.

In conclusion, the combination of a 30 foot buffer with *P. gigantea* application was insufficient to prevent the localized spread of annosum root rot. A future annosum management trial could be improved by increasing the 30 foot buffer and treating the residual stumps with an alternative annosum control substance such as Sporax®.

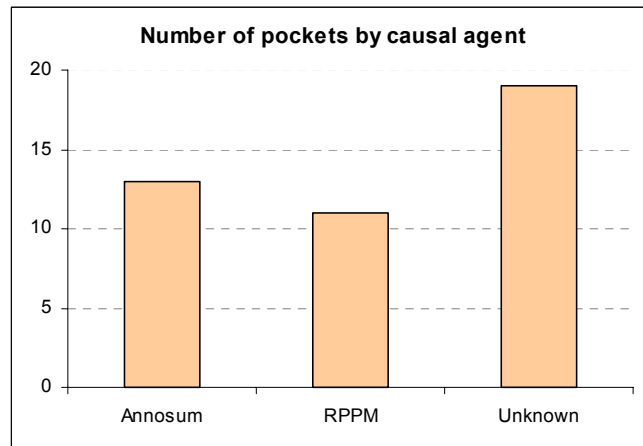


Figure 3. Pockets with presently active tree mortality grouped by causal agent within the Sauk County Forest.

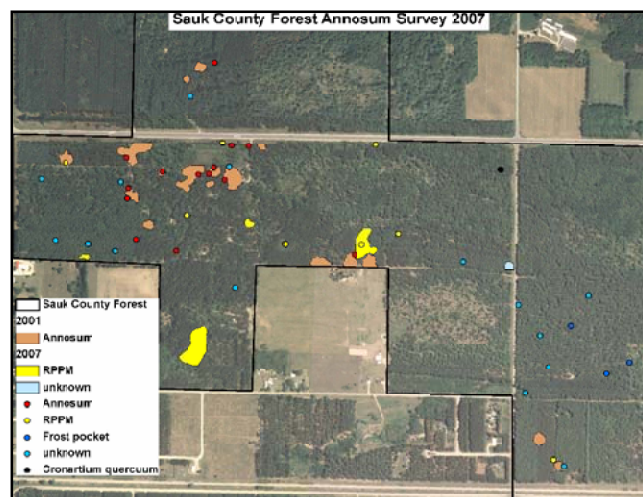


Figure 4. Sauk County Forest displaying the annosum pockets discovered in 2001, annosum pockets discovered in 2007, currently active red pine pocket mortality (RPPM), and other pine mortality.

Suppression:

Gypsy moth (*Lymantria dispar*) populations remained low due to a collapse in 2004, but have continued to rise since then due to the warm, dry summers of 2005 and 2006. South-central Wisconsin is looking like the next region of the state to see widespread outbreaks. This area is very favorable gypsy moth habitat, with a lot of oak growing on sandy soils. Populations in eastern Wisconsin have also risen but remain relatively low. There were a number of reports of individual trees being defoliated, but there were no large patches of defoliation reported.

This year's DNR suppression program was very small, with 4 participating counties (Brown, Fond du Lac, Manitowoc, Rock) and approximately 1,500 acres sprayed. Treatments were conducted at a dosage of 36 BIU of Btk. At present, the 2007 spray program is likely to be even smaller, as several counties have been hesitant to participate due to the lack of federal cost sharing. However, this trend is likely to reverse if populations continue increasing as they have in the past 2 years. In eastern Wisconsin, numerous spots are simmering at levels too low to spray in 2007, but could easily qualify for spraying in 2008.

Slow The Spread:

In Wisconsin, the slow-the-spread program is conducted by the Wisconsin Dept. of Agriculture, Trade, and Consumer Protection (DATCP). Eighty-seven sites in 21 counties were treated, for a total of 157,000 acres (DATCP submitted data).

Btk was applied twice at 24 BIU's to 27,025 acres, on 43 sites, and in 17 counties.

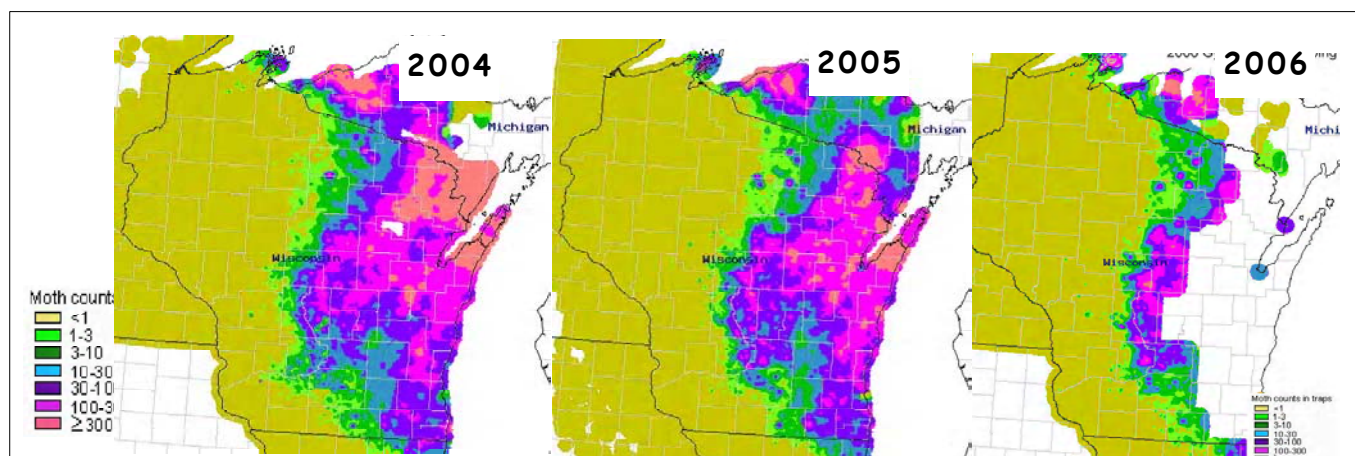
Gypchek (NPV) was applied once to 6,124 acres, on 16 sites, and in 4 counties.

Pheromone flakes were applied to 123,602 acres, on 28 sites, and in 9 counties.

Gypsy Moth Trapping:

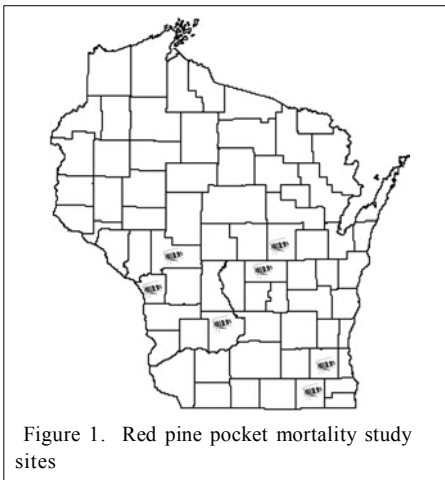
2006 was the first year that no widespread gypsy moth trapping was conducted in eastern Wisconsin, where the moth is widespread and has been well established for 10 years or more. DNR gypsy moth staff decided that the trapping information in these counties was no longer worth the cost of obtaining the data.

In western Wisconsin, DATCP continued trapping. A total of 92,209 moths were captured in 31,813 traps. Trapping grids were established at 1 per sq mi, 1 per 4 sq mi, or 1 per 9 sq mi. 200 delimitation blocks were set at 4 per sq mi or 9 per sq mi. Traps were set in 49 Wisconsin counties. Only 5 counties reported a zero moth capture (Buffalo, Pepin, Pierce, Polk and Washburn). Cooperators caught 29,146 moths in 588 traps – mainly in the Apostle Islands.



DNR-UW Madison Collaborative Study: Robert Murphy

Year three of the five year collaborative study between the DNR and Dr. Kenneth Raffa, UW-Madison Department of Entomology concluded with completion of the third year of insect monitoring and tree evaluations, as well as the initiation of two studies involving Southern Illinois University and Ohio State University. All studies hope to better our understanding of the driving forces involved with this destructive red pine phenomenon.



Red Pine Pocket Mortality is complex interaction of various agents contributing to pockets of tree death throughout Wisconsin, changing the landscape as it spreads within a stand. Our emphases are on insect vectors of tree weakening fungi, fungal spread by means of root grafting, insect biodiversity and red pine physiological response within and outside the stands. Through trapping we are monitoring the populations and predators of insect carriers of fungi, *Leptographium* spp and *Ophiostoma* spp. Root weevils, the red turpentine beetle (*Dendroctonus valens*), and bark beetles (*Ips* spp.) are the main culprits responsible for transporting the fungi to the tree. From previous studies, root insects, such as weevils, enter the tree root collar, spreading *Leptographium* fungi, stressing the tree, thereby making the tree susceptible to bark beetle attacks and spread of their associated fungus, *Ophiostoma*. Root grafting between healthy and diseased trees facilitates fungal spread and pocket formation.

We have 31 sites in 7 counties (Figure 1) in central and southern Wisconsin on both private and public lands. Eight sites are asymptomatic controls, and 10 sites are untreated symptomatic controls. Thirteen manipulated sites have had their root grafts severed 10 meters in advance of the last symptomatic tree. We hypothesize that severing the roots will obstruct transmission of the fungus to healthy trees.

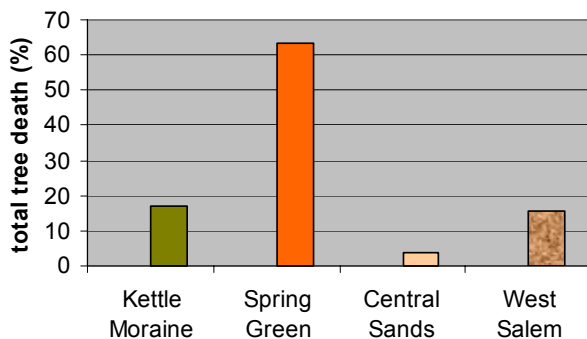


Figure 2. Total tree mortality from 2004 to 2006

Over the past three years traps were placed at each site to monitor insect populations. At all root-severed sites 12 jug traps and pitfall traps baited with either terpene delta-3-carene (jug trap) or terpene alpha-pinene (pitfall trap), were set two rows outside of the sever line. The asymptomatic and untreated symptomatic sites have four of each trap. In addition, four 12-funnel Lindgren funnel traps were placed at the 31 sites, two traps baited with Ipsenol and two with Ipsdienol and Lanierone. These pheromones are utilized to monitor bark beetle population densities.

We conducted sampling of jug and pitfall traps (456 traps total) from early April until mid-July and funnel traps (124 total traps) from April until mid-September. Insect identification of 34 insect species in 10 families is ongoing. We anticipate completing the 2005 samples by the spring of 2007. Annual tree evaluations concluded in November 2006.

Bark beetle and pine sawyer exit holes, the number of pitch tubes caused by the red turpentine beetle, a sub-sample of 24 trees per site for root collar weevil damage and the tree condition based on crown health were recorded. Of the nearly 10,000 trees in the study, 464 trees have died to date, with 80% of the mortality in the southernmost regions (Fig.2).

Field work for a tree physiology study (lead by Ohio State University) began in late May and concluded at the end of June. Two sites in the regions of Kettle Moraine (Southern Unit), Spring Green and West Salem, were selected for the experiment. Ohio State University will analyze the tree defense response to induced fungal inoculation. This study aims to further our understanding of physiological differences among trees within the pocket and those along and those beyond the pocket margin.



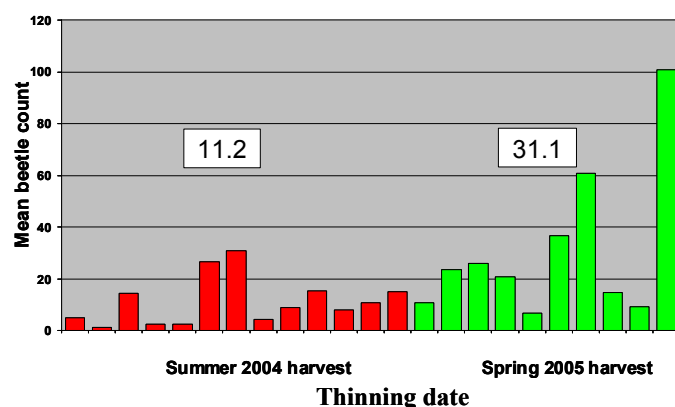
Dendroctonus valens

The first year of an insect dispersal study involving Southern Illinois University was also completed. Experiment sites were selected in Kettle Moraine (Southern Unit) and in Black River State Forest. Three insects prevalent in red pine pockets include the bark beetle pine engraver, *Ips pini*, the lower stem invader red turpentine beetle *D. valens* (see photo) and their predator, the checkered beetle *Thanasimus dubius*. A population of each of these insects was captured on site, marked, released from a central location and recaptured using funnel traps. The study seeks to learn the dispersal behaviors of these insects and the interconnectedness of existing red pine pockets to newly forming pockets. The experiment will be replicated in 2007 in Black River State Forest.

Turpentine beetle densities and timing of harvest: Sally Dahir

The initiation of red pine pocket mortality into a stand may be correlated with the presence of the red turpentine beetle (*Dendroctonus valens*) which is known to vector the pathogenic fungi, *Leptographium* spp. into red pine stands. Studies from the western United States (Goheen and Hansen 1978, Witcosky et al 1986) indicate that stand disturbance or thinning, and more precisely the time of year in which thinning occurs, may be correlated with the presence of *Hylastes nigrinus* beetles and infection with black stain fungi in the douglas fir ecosystem.

In order to test this hypothesis in Wisconsin, we initiated a study in 2005, comparing beetle densities in stands thinned the previous summer to densities in recently thinned stands. We suspected that stumps thinned in the summer, several months before beetle flight in April-May, might be drier and less attractive to emerging beetles than stumps thinned immediately preceding flight. The results in 2005 (see chart), revealed a significantly higher number of beetles in the spring-thinned stands as hypothesized. However, as you can see, the variability between stands was quite high.

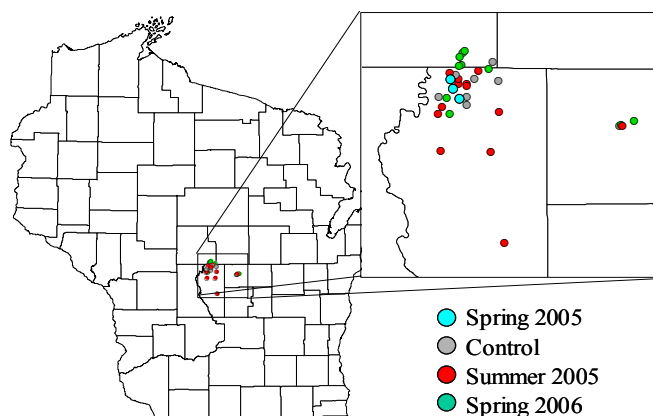


Results from 2005 trapping show a higher number of beetles per trap in the spring thinned stands.

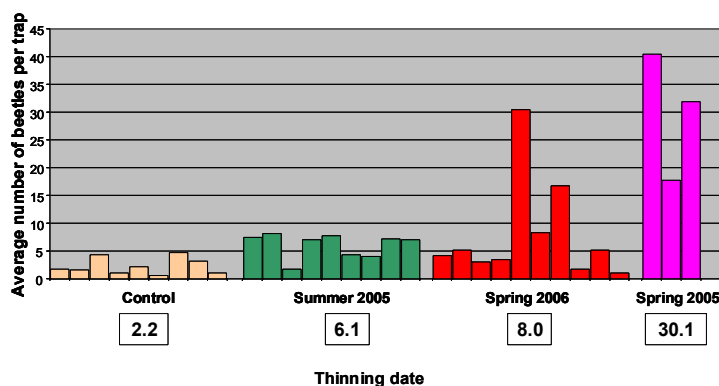
In 2006, in order to reduce this site-to-site variability, traps were placed in stands all within one area of the central

sands on property belonging to Plum Creek (see map). Traps were also set in a private property in Waupaca County where thinning occurs year round. We also decided to trap in red pine that hadn't been thinned in more than 5 years as a comparison or control. This would have meant 3 categories of stands; controls, summer 2005-thinned, and spring 2006-thinned. However, 3 of the stands which had been categorized as thinned in the summer of 2005 had actually been thinned in the spring of 2005, adding another category: spring 2005-thinned.

The results of the 2006 trapping (see chart) continue to support the hypothesis that the time of year in which thinning is conducted is correlated with beetle populations but there is still very high variability within each category. Beetle counts in the control and the summer 2005 groups are consistently low with limited variability but both spring-thinned groups show greater variability with several stands having very high numbers of beetles. Interestingly, on the private property, where spring-thinned, summer-thinned and controls are located within a short distance of each other, the hypothesis holds quite strongly, i.e. the spring-thinned stands have much higher beetle counts than the summer-thinned or control stands.



Turpentine beetle trapping sites in spring 2006



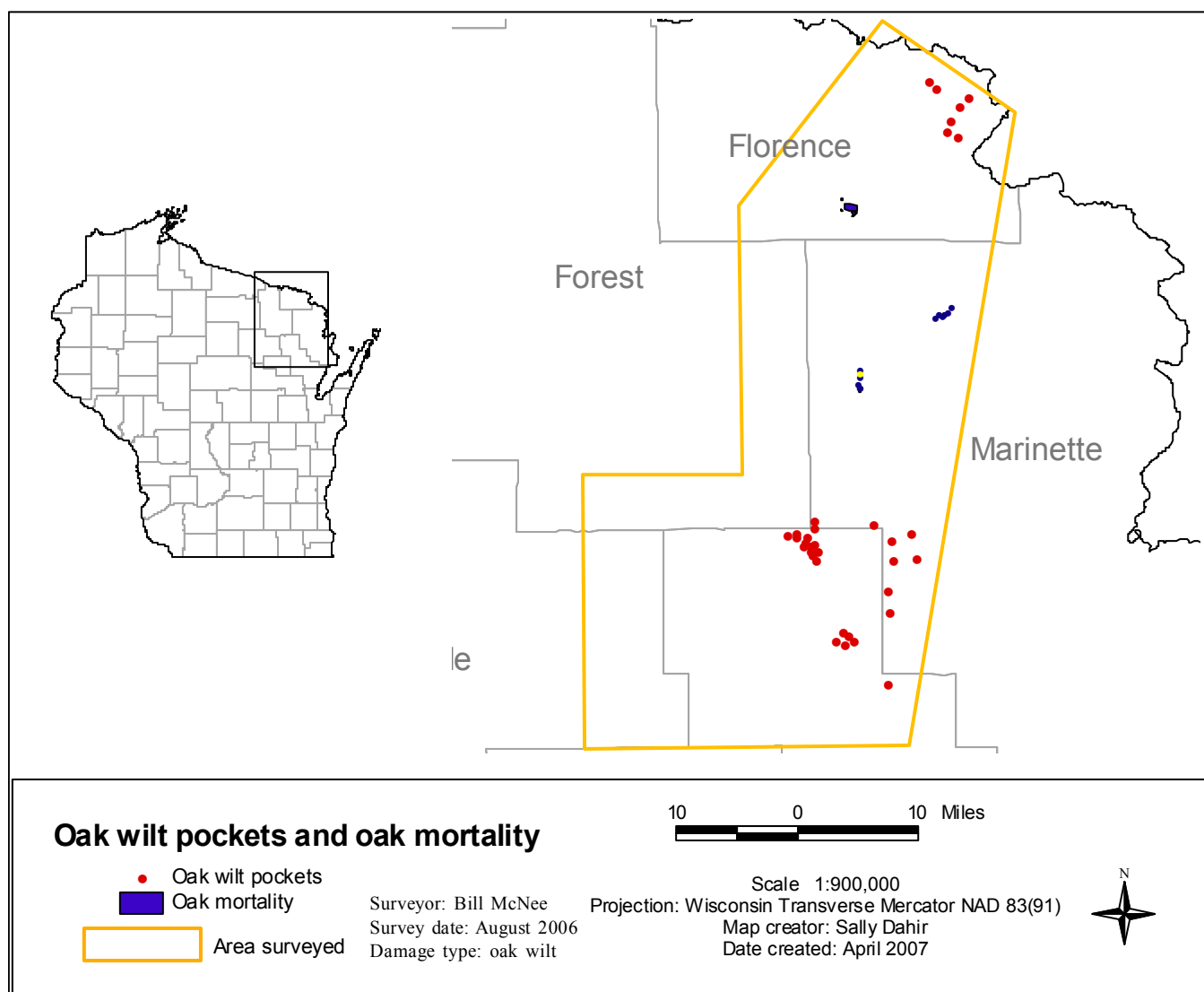
Average number of beetles per trap for stands thinned at different times. The average for the category is given below.

Trapping was repeated in April of 2007, with greater attention paid to locating stands within one geographic area and to determining more exactly the start and end dates of thinning to better categorize stands. In addition, we will monitor stands that showed high counts in the past 2 years to see if the density of beetles remains high or decreases.

In August 2006, two survey flights were conducted in eastern Wisconsin to determine whether oak wilt had spread into counties not known to have the disease. Kewaunee, Calumet, Manitowoc, and Sheboygan counties were surveyed along the lakeshore. The eastern portions of Forest and Langlade counties were also flown. Oak wilt pockets



were not observed in any of these counties. However, the disease had increased in intensity in northern Oconto and eastern Florence counties (see map), where oak wilt has been a problem in recent years.



Introduction

The fungus, *Diplodia pinea* (syn. *Sphaeropsis sapinea*, *Sphaeropsis ellisii*) attacks over 30 species of pines and many other conifers throughout the world. In Wisconsin, the fungus most often infects red pine although infection has also been observed on other pine species. When the fungus attacks shoots, affected shoots become curled, stunted and die. The fungus enters wounds and develops cankers on twigs, branches and stems. The fungus also invades the tissue in the root collar area of seedlings and causes collar rot. Infected wood in the root collar area exhibits blue/black discoloration, although this is not a definitive diagnosis of the disease in seedlings. Once girdled, a sudden mortality of seedlings occurs. Fruiting bodies (pycnidia) of *D. pinea* are formed on infected needles, shoots, bark, and cones. Spores (conidia) are dispersed during wet weather in spring through fall.

Mortality of red pine seedlings associated with the fungus *D. pinea* has been a serious concern for Wisconsin's state nurseries (Palmer and Nicholls, 1985), as well as for other forest nurseries across the Lake States. A Wisconsin state nursery study conducted in 2002 reported 21% (high inoculum pressure) and 1% (low inoculum pressure) for the frequency of symptomatic seedlings in Griffith Nursery, 26% (high inoculum pressure) and 12% (low inoculum pressure) in Hayward Nursery, and 43% (high inoculum pressure) and 8% (low inoculum pressure) in Wilson Nursery (Stanosz et al. 2005). These symptomatic seedlings are culled prior to shipping for graded stocks and bulk orders include sorting guidelines instructing landowners to remove symptomatic seedlings before planting.

Though symptomatic seedlings are mostly removed prior to planting, recent research revealed that the fungus could persist in or on the seedlings without showing symptoms, and become active once a tree is stressed - primarily from moisture deficit (Stanosz et al. 1997; Stanosz et al. 2001). In the aforementioned 2002 state nursery study, apparently healthy-looking (asymptomatic) seedlings were tested for the presence of *D. pinea*. The test resulted in 35% (high inoculum pressure) and 3% (low inoculum pressure) for the frequency of asymptomatic seedlings that were positive for *D. pinea* in Griffith Nursery, 30% (high inoculum pressure) and 24% (low inoculum pressure) in Hayward Nursery, and 63% (high inoculum pressure) and 8% (low inoculum pressure) in Wilson Nursery (Stanosz et al. 2005).

Following this study, the state nurseries implemented an aggressive program to monitor and control *Diplodia* shoot blight and canker in red pine seedlings. A *Diplodia* management plan was developed and implemented in all Wisconsin state nurseries. In order to evaluate the effectiveness of the *Diplodia* management plan and the IPM (Integrated Pest Management) practices used to control the disease, it is imperative to assess the frequency of asymptomatic red pine seedlings that are infected with *D. pinea*. The summer of 2006 was the first time Wisconsin DNR systematically tested its red pine seedlings prior to shipping. The purpose of the testing was to provide baseline data to evaluate our continuing efforts to control the disease, as well as to ensure the highest quality of red pine seedlings grown and sold in the Wisconsin state nurseries.

Materials and Methods

Two-year-old red pine seedlings were sampled from Griffith and Wilson Nurseries. Seedlings were not collected from Hayward Nurseries because the majority of 2-0 red pine seedlings had been killed or severely damaged by spring frost in 2005. Seedlings were collected from every other row in both nurseries. Each row was divided into three sections and a sample plot was determined by placing a yard stick arbitrarily within each section. Five

seedlings were collected from each plot. Only apparently healthy seedlings were selected for this survey. Seedlings were cut just below the ground line with clippers to make sure that root collar areas would be included. Seedlings were placed in a separate plastic bag for each plot and each bag was securely sealed. Seedlings were collected from 60 plots (20 rows) in Griffith Nursery and 27 plots (9 rows) in Wilson Nursery. Samples were placed in a cooler with ice while delivered, and stored in a refrigerator at 4C upon arrival in the lab. All seedlings were processed within 36 hours after sampled.

In the laboratory, each seedling was cut into a two-inch-long stem segment that contained lower stem and root collar. All needles were carefully removed from the stem segment. The stem segment was surface disinfected by submerging in 95% ethanol for 30 seconds with agitation, then in 1.05% sodium hypochlorite with two drops of Tween-80 with agitation for 2 minutes.



A Petri plate with a stem segment and sterile needles

Each stem segment was placed on one side of tannic acid agar in a 100 x 15mm Petri dish (Stanosz et al. 2005). Segments of green-red pine needles were autoclaved twice each for 30 minutes. The needle segments were placed on the other side of the Petri dish. Petri dishes were incubated in the dark at ambient room temperatures for two weeks, and then placed under fluorescent lights in the laboratory.



Dr. Stanosz teaches Forest Health staff testing protocols

First evaluation of plates was conducted 5 weeks after samples were processed, and final evaluation was performed 4 weeks after the first evaluation to ensure that the fungus had enough time to grow. Formation of pycnidia on stem segments and sterile red pine needles was examined and positive identification of *D. pinea* was made based on conidial characteristics of the fungus through a compound microscope.



Diplodia pinea conidia

Results

The percentage of positive seedlings per plot varied from 0 to 100 percent. There was no apparent difference among different nursery beds or locations of samples (first, second and third segment of rows). Based on the first examination, 79.0% of the seedlings sampled in Griffith Nursery and 10.2% in Wilson Nursery were positive for *D. pinea*. During the second examination, additional plates from Griffith Nursery were confirmed positive, however no additional plates were found positive for samples in Wilson Nursery. In total, 86.7% of 300 seedlings from Griffith Nursery were confirmed positive, and 10.2% of 135 seedlings from Wilson Nursery.

Discussion

A positive relationship between the incidence of symptomatic and asymptomatic red pine seedling infection by *D. pinea* and proximity to host windbreak trees and the importance of the removal of windbreak trees to reduce the incidence of this disease have been documented (Palmer et al. 1988; Stanosz et al. 2005). In order to eliminate the possibility of seedling infection from nearby windbreak trees, removal of all red and jack pine trees was completed in 2006 within Griffith and Wilson nurseries. At the Hayward Nursery, the majority of host windbreak trees were removed earlier and the rest were marked for removal in 2006. In

some cases, host trees are located outside of nursery property boundaries and cannot be removed. Investigation of the disease gradient in beds located adjacent to red pine windbreaks at Wilson Nursery indicated a significant decrease in *D. pinea* occurrence within the first 100 meters from the inoculum source (Palmer et al., 1988). High hazard areas will be identified based on proximity to outside inoculum sources and the nurseries will try to plant only non-susceptible species within these beds.

Previous surveys conducted in Griffith Nursery reported an average of 21% asymptomatic infection in 1994 (Stanosz et al. 1997) and 35% in 2002 (Stanosz et al. 2005). Though the cause of high frequency of asymptomatic infection in Griffith in 2006 is unknown, it is suspected that a fungicide application may have been missed on 1-0 red pine seedlings in 2005. It is expected that the frequency of asymptomatic infection on red pine seedlings will dramatically decrease in all state nurseries with the completion of windbreak tree removal and fungicide applications.

Based on the lab results, all 2-0 red pine seedlings in Griffith Nursery were removed from the market in the fall of 2006 in order to ensure the highest quality of stock for their customers. Wisconsin state nursery red pine seedlings will continue to be monitored and tested in 2007.

Depending upon the outcome of the sanitation and monitoring efforts, future research may be needed into additional *D. pinea* control measures. The future research needs include the investigation of seeds and irrigation water as a potential source of *D. pinea* inoculum. The Wisconsin DNR will continue to seek for opportunities to have collaborative projects with other agencies, such as University of Wisconsin and USDA Forest Service for the management of this disease.

Acknowledgments

We thank Dr. Glen Stanosz and Denise Smith of University of Wisconsin-Madison, Department of Plant Pathology, for providing us with technical expertise to conduct this test. Without their support, it wouldn't have been possible to ensure the same quality standard of the testing procedures.

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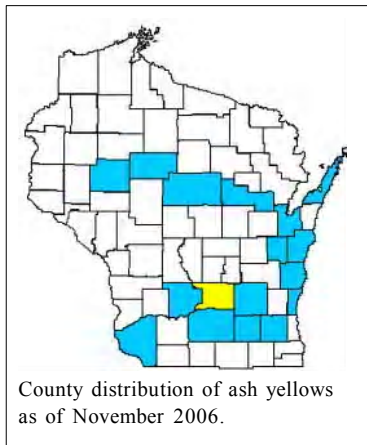
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All three nurseries follow the fungicide application schedule (Palmer and Nicholls 1986; Stanosz and Smith 1996) and will switch from benomyl to alternative fungicides, such as thiophanate-methyl and chlorothalonil, as benomyl supplies are depleted.

Minor Issues

Ash Yellows

Ash yellows is caused by a phytoplasma, a wall-less bacteria-like microorganism. Symptoms of ash yellows include yellow/sub-normal size foliage, slow twig growth, thin crown, branch dieback and vertical cracks on the trunk near the ground, as well as brooms. In 2006, ash yellows was confirmed in Columbia County (yellow on map), based on the presence of brooms. Ash yellows is confirmed in 17 Counties in Wisconsin.



Visual surveys conducted to detect the emerald ash borer in 2005 showed that approximately 1/3 of the trees examined exhibited branch dieback. Other problems recorded on the trees included yellow leaves, epicormic sprouting, tufted foliage at tips of twigs, and bark cracks. These symptoms that indicate stresses and reduced vigor were attributed to wounds, girdling, improper planting, and water stress. Furthermore it was suspected that some of

these trees may be infected with ash yellows. In the summer of 2006, leaf and wood samples were collected from trees that were showing branch dieback from 8 campgrounds and 2 forest stands from 10 counties (Douglas, Iowa, Kenosha, Lafayette, Marinette, Monroe, Oconto, Oneida, Richland, and Taylor counties.) Some of the sampled trees also exhibited yellow/subnormal size leaves, slow twig growth, and/or epicormic sprouting, but no brooms. Samples were tested for the presence of phytoplasma through the genetic analysis by Dr. Glen Stanosz, University of Wisconsin, Department of Plant Pathology. All of the samples were negative for phytoplasma.



Tar spot on Norway Maple



Tar spot was observed causing severe leaf spotting and defoliation on Norway maple in Waukesha County throughout the Village of Chenequa. It was also observed causing similar problems on Norway maple in a city park in the city of Sturgeon Bay in Door County. A report also came in from a homeowner in Sheboygan County this year. The early cool wet spring weather likely played a role in the outbreak of this leaf spot disease.

Based on host information it was likely *Rhytisma acerinum* causing the problem. According to Wayne Sinclair's book, Diseases of Trees and Shrubs, this species of *Rhytisma* was first described in Europe and subsequently found in Ohio in 1940. In the 1980's, it caused outbreak levels in Norway maple in New York but was often misidentified as the native *Rhytisma americanum* species. Speckled tar spot caused by *R. punctatum* is also mentioned as common but has a similar host range as *R. americanum* with a few exceptions.

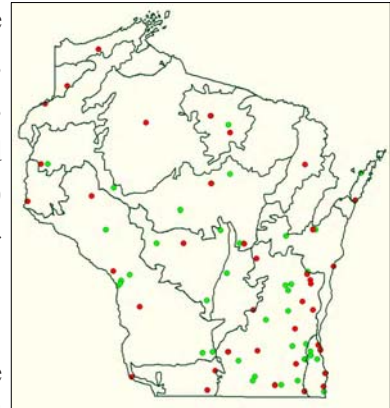


Hail and *Diplodia* canker in Columbia County

On June 25, 2006, a slow-moving severe thunderstorm hit north of Poynette, Columbia County with golf-ball size hail. By early August, red pine plantations in the affected area exhibited severe branch dieback. Laboratory examinations revealed branch cankers caused by the fungus, *Diplodia pinea*, starting from wounds inflicted by hail. In severely affected areas, damage reached 80-100 % of the crown, and the entire crown appeared reddish brown. Approximately 117 acres of pole-size red pine plantations suffered damage, and more than 6,000 cords of red pine were salvage harvested. Although branches of nearby white pine were also injured by hail, they sustained only minor branch tip mortality.

Sudden Oak Death

This was the third year Wisconsin surveyed oak stands within 0.25 miles of nurseries that have received plant material from infested areas of California. All samples in 2004 and 2005 were negative for the presence of *Phytophthora ramorum*, the fungus that causes sudden oak death (SOD). In 2006, 38 sites were sampled; 118 foliage samples were collected. Sampling in all of Wisconsin's ecological landscapes revealed negative results, but vigilance remains the prudent course of action, as over 80 Wisconsin nurseries received stock from a known infected California wholesaler in 2003.



SOD tissue sampling 2004-2006 by Ecological Landscapes (green=2004 and 2005; red=2006). Twenty-one locations have been sampled in multiple years.

Tentatively, UW Stevens Point professor Neil Heywood and students from the Department of Geography & Geology, in cooperation with WDNR, DATCP, and USDA Forest Service personnel, will conduct a surveillance survey during 2007, with focus upon water sampling. SOD monitoring surveys within Wisconsin between 2004 and 2006 have yielded *no confirmed positives*. Additional information regarding symptoms and prevention is available through a USDA National Forest Service web site:

www.na.fs.fed.us/spfo/pubs/pest_al/sodeast/sodeast.pdf

Sugar Maple Defoliation



Frost damage on emerging sugar maple leaves.

Sugar maple defoliation was observed in June in Vilas, Forest, and Florence counties. Linden Looper was initially suspected because looper feeding was reported in the western Upper Peninsula. Several sites were visited in June and many dominant/co-dominant sugar maples showed extensive defoliation in the upper crowns. Closer examination revealed dead buds, small dead leaves, leaves with a tattered appearance, a heavy seed crop, and minimal insect feeding. These symptoms are suspected to be related to frost and/or wind damage to emerging succulent tissue.

On May 12, when new, tender leaves were just emerging and expanding, Wisconsin had an entire day of very strong winds across the state. These strong winds damaged the tender

leaves, as the leaves continued to grow and expand the damaged part (primarily the tissue between the leaf veins) turned brown and decomposed, giving the leaf a tattered, defoliated look. Additionally, these tender leaves in the upper crowns were affected by a late frost which occurred after the Memorial Day weekend. Frost damage to young leaves was common in the crowns of defoliated trees. At the time of the site visit the trees were sending out a second set of leaves to replace the damaged ones. There was very little branch dieback. Therefore, longterm health effects should be minimal.

Siricid Woodwasp (European) **2006 Survey Interim Summary**

Overview:

Wisconsin is currently considered low risk for establishment of and susceptibility to an exotic woodwasp, *Sirex noctilio*, but is at a higher risk for possible introduction in or near Milwaukee and Green Bay. The primary goal of this survey was to test and compare three detection methods for the presence of Siricid wasps. The three methods tested were 1) Lindgren funnel traps baited with a Siricid lure (70% α /30% β pinene) using a dry collection cup with a pesticide kill strip 2) Siricid intercept panel trap also baited with a Siricid lure (70% α /30% β pinene) using a water kill collection cup, and 3) detection tree stressed by frill cut with herbicide treatment. This interim summary covers the first two methods. The detection tree survey will be completed next spring when the trees will be felled and peeled to look for Siricid larvae. A secondary goal was to survey a portion of the Kettle Moraine State Forest Northern Unit for the presence of *Sirex noctilio*.



Survey design:

Three sites were located in the Kettle Moraine State Forest Northern Unit in southeast Wisconsin. The three sites were mature red pine plantations with some level of stress due to insect, disease, and/or overstocking. Within each site 5 repetitions of the three survey methods were randomly set up in a grid pattern. Each repetition was set up ~ 1 chain apart. Traps were checked every three weeks and any Siricids caught were collected and stored in 90% rubbing alcohol.



Far left: Lindgren funnel trap
Near left: Intercept panel trap
Below: Frill cut and herbicide
detection tree.
Right: Three sites located in
the Kettle Moraine State
Forest Northern Unit

Results of intercept panel and Lindgren funnel traps:

Collection Date:

7/12/06 - 3 collected from Intercept Panel trap, 1 from Lindgren funnel trap
7/31/06 - 10 collected from Intercept Panel trap, 0 from Lindgren funnel trap
8/23/06 - 0 collected from Intercept Panel trap, 1 unidentified hymenopteran from funnel trap
10/12/06 - 2 collected from Intercept Panel Trap, 0 from Lindgren funnel trap

Totals:

Intercept panel trap- 15 Siricids females
Lindgren funnel trap- 1 Siricid female, 1 unidentified hymenopteran with abdomen missing

There appears to be 6 possible different species of Siricids based on abdomen and antennae color patterns. None appear to be *Sirex noctilio*. Specimens still need to be identified.

Comments:

Intercept panel traps seemed to outperform the Lindgren funnel traps in catching Siricid woodwasps. Some of the variation could be due to kill cup method. Peak catch occurred between July 12 and July 31st. An interim report on survey methods and results will be submitted to the WI Forest Health annual report for 2006.

Oak dieback and mortality

Branch dieback and mortality of white and bur oaks have been observed in southern Wisconsin in recent years. It is suspected that affected trees were stressed by one or multiple factors, including frost, oak tatters, Anthracnose, Tubakia leaf spot (*Tubakia dryina*), mites, and drought. Once the trees were stressed, they were attacked and killed by secondary pests such as the two-lined chestnut borer (*Agrilus bilineatus*) and Armillaria root disease. This year, some of the recently dead trees and trees exhibiting dieback were tested for the presence of oak wilt (*Ceratocystis fagacearum*); oak wilt was found to be present in a few of the symptomatic trees

Oak wilt herbicide trial in the Nine-Mile Recreation Area on the Marathon County Forests Update

An herbicide field trial was initiated in the Nine-Mile Recreation Area on the Marathon County Forest in 2003 as an alternative to physical root severing by a vibratory plow. Trees within grafting distance were identified by using Johann Bruhn's model, and these trees were treated with Garlon 4 (active ingredient: triclopyr) in early July 2003. Additional trees were treated in early July 2004 (for the details of the treatment in 2004, please refer to an article, titled "Oak wilt Marathon County Control Trial: 2004 updates on the herbicide trial in the Nine-Mile Recreation Area on the Marathon County Forest, page 16). In 2005, the site was closely monitored and no additional trees exhibited the symptoms



Herbicide treatment for oak wilt

of oak wilt at the site. However, a new oak wilt pocket was found in the Marathon County forest, approximately 1/4 mile away from the original herbicide trial site. In 2006, the original site was again closely monitored throughout the growing season. No further spread of the disease was detected. The new oak wilt pocket that was found in 2005 was treated with Tahoe 4 (active ingredient: triclopyr) in late June, 2006. Trees within grafting distance were determined using Johann Bruhn's model. No additional oak wilt was found in the Nine-Mile Recreation Area in 2006, thus no herbicide treatment is scheduled in 2007.

Both the original site and the new site that was treated in 2006 will continue to be monitored through weekly visits by county forest personnel during the summer 2007. We thank Doug Brown, a Marathon County Forester, for providing us with periodical updates on the progress of the trial.

A similar herbicide treatment was implemented in a private property in Dane County in 2006. Oak wilt was found at the site in 2005 and dead trees were removed in December 2005. Trees within grafting distance were determined by a professional arborist and marked trees were killed by Garlon 4 in early July 2006. Stumps and girdled trees in the pocket and surrounding healthy trees were individually marked by GPS in late July. The site will be monitored by the WI DNR Forest Health personnel in 2007.

Sudden Oak Death Detection Survey 2006 in Wisconsin

Oak mortality known as Sudden Oak Death has been observed in coastal California and Oregon since 1990's. This disease has been killing many tanoaks (*Lithocarpus densiflorus*), coast live oaks (*Quercus agrifolia*), and California black oaks (*Quercus kelloggii*) and other oak species. The causal agent was identified as a fungus-like organism, *Phytophthora ramorum* in 2001. The fungus causes a bleeding canker on the stem of oak species, and infected oak trees often die several years after infection. The pathogen also causes leaf spot and twig dieback on other hosts, such as rhododendron and bay laurel. These hosts can be a reservoir of *P. ramorum*.



Black or reddish ooze often bleeds or seeps from the canker

In 2003, nursery stocks from a known infected nursery in southern California were shipped to several states, including over 80 nurseries in Wisconsin. This prompted a national survey in 2004, and 2006 was the third year that Wisconsin participated in the *Phytophthora ramorum* detection surveys. Nurseries in Wisconsin has been inspected by the Wisconsin Department of Agriculture, Trade and Consumer Protection and The Wisconsin Department of Natural Resources has been examining nearby oak stands that are located within 0.25 miles of nurseries that have received plant material from the infected nursery in California and general oak stands throughout the state. Foliar samples with leaf spots of known understory hosts have been collected and tested for the presence of *P. ramorum* using a genetic analysis, a nested PCR (Polymerase Chain Reaction). All the survey work and collection of samples were conducted by the profes-



sor, Dr. Neil Heywood, Department of Geography & Geology, University of Wisconsin at Stevens Point and his students. Each sample was sent to two independent labs, Ohio State and Mississippi State labs for the analysis. All samples that were collected in 2004 and 2005 were negative for *P. ramorum*.

In 2006, 38 sites were inspected and 118 foliage samples were collected. Based on the preliminary analysis, samples from 2 sites that are in close proximity came back positive for *P. ramorum* from Ohio State lab. Four samples from Illinois were also positive through the test conducted by Ohio State lab. None of the samples tested by Mississippi State lab was positive. As a first response to this preliminary result, a follow-up PCR test was conducted using remaining original samples. The results of the test using the remaining samples were the same as the first test. Both samples were positive in Ohio State lab, and negative in Mississippi State lab. Original foliar samples were also sent to a lab in the USDA Forest Service as a third independent testing lab. The results from the Forest Service lab included both positives and negatives.

Additional foliar samples were collected by Dr. Heywood from the two sites and sent to both Ohio State and Mississippi State labs. The results were negative for all samples from both labs. As a cautionary follow-up, additional samples were collected in November to test



Leaf spot symptoms on rhododendron.

for the presence of *P. ramorum* in two sites where original samples had been tested positive. This time, instead of foliar samples, water and soil samples were collected and bait traps were installed both upstream and down stream from where original samples were collected. Water samples were collected from 3 locations and soil samples were taken from 2 locations both upstream and down stream for each site. A bait trap is a square mesh bag with four leaves of *Rhododendron maxima*, and the traps were placed to float on a stream.

Water samples were filtered the same day and soil samples were sent by overnight courier to the lab for baiting. Processed samples were incubated for 2 weeks before final examination for the detection of *Phytophthora* species. After being exposed in a stream for 3 weeks, bait traps were transported to the lab for isolation of *Phytophthora*.

All samples were processed by Dr. Jaesoon Hwang of Clemson University. Several of the bait bags deployed in streams were lost when water froze; bags had to be chipped out of the ice to recover baits. From water samples, *Phytophthora* spp. were recovered from all waterways at both sites, however *P. ramorum* was not recovered. Several species of *Phytophthora*, including *P. cactorum*, *P. citricola*, and other *Phytophthora* sp.) were recovered from three of the four soil samples, though again *P. ramorum* was not detected.

It is suspected that the original positive result was due to the cross contamination of samples through the process. The USDA Forest Service believes that the nested PCR is not the most reliable method to detect *P. ramorum* due to the difficulty of separating *P. ramorum* from other organisms and complicated process of the test that could allow errors. Filtration method appears to be much more effective and productive. The Forest Service plans to shift from taking understory foliar samples to the use of water samples and bait traps for 2007. In 2007, bait traps will be placed in a 1-2 week period per month for 5 months from May through September. As a final confirmation, additional

samples will be collected from the two sites in southeast Wisconsin that were originally positive in 2006 as well as other samples, and will be tested by isolation of symptomatic leaf tissues on a selective medium with a genetic analysis using a real-time PCR on suspect cultures as a follow-up.

At this point, the causal pathogen of Sudden Oak Death, *Phytophthora ramorum* has not been confirmed in Wisconsin through the Sudden Oak Death monitoring surveys between 2004 and 2006. Additional information regarding symptoms and prevention is available through a USDA National Forest Service web site: www.na.fs.fed.us/spfo/pubs/pest_al/sodeast/sodeast.pdf

Annosum root rot: 2006 update

In 2006, Annosum root rot was found in a red pine stand in Columbia County. Infection was found on a 47-year old red pine plantation that was last thinned in 2001. It is suspected that fresh stumps provided an entry court for the fungus, and the disease has spread to nearby trees through root contact. This brings the total number of counties with this disease to fifteen (Adams, Buffalo, Columbia, Dunn, Green, Iowa, Jefferson, LaCrosse, Marquette, Richland, Sauk, Trempealeau, Walworth, Waukesha, and Waushara Cos.).

Annosum root rot is caused by the fungus, *Heterobasidion annosum*. The fungus causes a decay of the roots and butt and often kills infected trees. In Wisconsin, Annosum root rot has been found primarily on red pine, and occasionally on white pine. The primary mode of infection is through freshly cut stumps. Spores land on the stump, grow through the root system, and infect adjacent healthy trees. Fruit bodies may be found at the root collar of dead/dying trees and stumps of infected trees. A publication outlining the symptoms/signs and management recommendations for Annosum root rot can be obtained at <http://www.dnr.state.wi.us/org/land/forestry/fh/fhissues/annosum.htm>.



Annosum fruiting body at the base of a red pine.

Other Pests Reported in 2006

Pest	Host	Damage	Location
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Aspen

Cottonwood Leaf Beetle (<i>Chrysomeia scripta</i>)	Cottonwood	Defoliation	Eau Claire County
Eastern Tent Caterpillar (<i>Malacosoma americanum</i>)	Aspen	Defoliation	Scattered West Central Region
Poplar Vagabond Aphid (<i>Mordwilkoja vagabunda</i>)	Cottonwood	Leaf distortion	Eau Claire County

Balsam Fir

Bark Lice	Balsam Fir	Bark lice hanging out on the trunk and moving in unison when disturbed	Marathon County
Pine Sawyer/ Whitespotted Sawyer (<i>Monochamus scutellatus</i>)	Balsam Fir	Larvae found feeding in recently dead tree	Marathon County
Rhizosphaera Needle Blight (<i>Rhizosphaera pini</i>)	Balsam Fir	Yellowing of new needles, eventually turning brown and falling off	Monroe County
Spruce budworm (<i>Choristoneura occidentalis</i>)	Balsam Fir	Light-moderate defoliation	2500 acres in Price County

Basswood

Anthrachnose (<i>Gnomonia tiliae</i>)	American Basswood	Leaves turned brown and curled, causing some premature leaf drop	Buffalo County
Linden Borer (<i>Saperda vestita</i>)	American Basswood	Mortality	Brown, Outagamie, Fond du Lac counties

Birch

Japanese beetle (<i>Popillia japonica</i>)	Birch	Skeletonized, lacy foliage	Columbia and Dane counties
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Cherry

Cherry Scallop Shell Moth (<i>Hydria prunivorata</i>)	Wild Cherries	Defoliation, leaves webbed together into a funnel shape	La Crosse County
Eastern tent caterpillar (<i>Malacosoma americanum</i>)	Black cherry	Moderate to heavy defoliation	Columbia, Dane, Green, Sauk, Walworth counties
	Wild Cherries and other hosts.	Defoliation of cherry and moved onto other hosts such as Aspen and Oak	Scattered West Central Region
Peach bark beetle (<i>Phloeotribus liminaris</i>)	Black cherry	Dieback/decline	Oconto County

Pest	Host	Damage	Location
Ugly Nest Caterpillar (<i>Archips cerasivorana</i>)	Wild Cherries	Leaves webbed together, and defoliated	Scattered West Central Region

Christmas Trees

Diplodia Shoot Blight (<i>Diplodia pini</i>)	Red Pine	New shoot mortality and branch flagging	Eau Claire County
Needle Scale	Unknown - did not take note of what species it was on.	White flecks on needles, the flecks being the mature scale insect	Unknown
Red Pine Shoot Moth (<i>Dioryctria resinosella</i>)	Red Pine	New shoots killed while expanding, resulting in red shoots on the end of the branches	Eau Claire County
Rhizosphaera Needlecast (<i>Rhizosphaera kalkhoffii</i>)	Colorado Blue Spruce	Needle discoloration and needle loss	Eau Claire County
Spruce Spider Mites (<i>Oligonychus ununguis</i>)	Balsam Fir	Needle discoloration and needle loss	Unknown
Unknown Weevil	Balsam Fir	Feeding damage on the bottom of branches	Langlade County
Armillaria Root Rot (<i>Armillaria mellea</i>)	Balsam Fir	Mortality of trees on sandy soil	Chippewa County
Balsam Fir Needle Rust (<i>Uredinopsis spp.</i>)	Balsam Fir	Yellowing of new needles, eventually turning brown and falling off	Jackson and Marathon counties

Crab Apple

Eastern Tent Caterpillar (<i>Malacosoma americanum</i>)	Flowering Crabs	Defoliation	Scattered West Central Region
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Elm

Dutch Elm Disease (<i>Ophiostoma ulmi</i>)	Elm	Tree mortality	Scattered West Central and Northwest regions, Grant and Dane counties
Elm leaf miner	Elm	Blotch mines on foliage	Dane and Green counties
Slime Flux/Bacterial Wetwood	Elm	Tree decline	Marathon County

Hickory

decline and mortality (unknown cause)	bitternut hickory	mortality	Calumet, Manitowoc, Shawano, Winnebago, Oconto, Sheboygan counties
Hickory Bark Beetle (<i>Scolytus quadrispinosus</i>)	Bitternut and Shagbark Hickory	Tree mortality	Marathon, Monroe, and Wood counties: Calumet, Manitowoc, Shawano, Winnebago, Oconto, Sheboygan counties
Hickory mortality	Bitternut and shagbark hickory	Dieback and mortality	Dane and Grant counties

Pest	Host	Damage	Location
Phomopsis Gall (<i>Phomopsis spp.</i>)	bitternut hickory	Tree mortality	Shawano Co
Pigeon Tremex (<i>Tremex columba</i>)	Bitternut Hickory	Laying eggs in declining trees and adults emerging out of others	Wood County
Unknown Wood Borer and Disease?	Bitternut and Shagbark Hickory	Tree mortality	Marathon, Monroe, and Wood counties

Maple

Anthracnose (<i>Discula spp.</i>)	Maple	Leaves turned brown and curled, and causing some premature leaf drop	Scattered West Central Region, Burnett, Washburn and Sawyer counties
Fall Webworm (<i>Hypantria cunea</i>)	Tag alder, birch, elm, ash, etc	Numerous tents present	Sawyer, Iron, Price, Vilas, Oneida, Taylor and Rusk counties
Maple bark disease (Cause unknown)	Norway Maple	Whitish discoloration & coating on bark (possible dried slime flux)	Fond du Lac and scattered locations in Southeast Region
Maple dieback: (Cause unknown)	Red maple	Small leaves, few leaves, upper crown appears defoliated	Shawano, Menominee, Oconto, Langlade, Forest counties
	Sugar and Norway maples	Branch dieback and some mortality	Dane County
Maple petiole borer (<i>Caulocampus acericaulis</i>)	sugar maple	Heavy leaf drop on scattered trees	Washburn & Sawyer counties
Sapstreak (<i>Ceratocystis coerulescens</i>)	sugar maple	Decline and mortality	Shawano County
Tar Spot (<i>Rhytisma spp.</i>)	Silver Maple	Tar-like leaf spot	Scattered West Central Region

Miscellaneous Pests

Boxelder bugs (<i>Leptocoris tririttatus</i>)		Congregating on homes	Brown, Outagamie counties
Fall Webworm (<i>Hypantria cunea</i>)	Various hardwood species	Webbing over branches and defoliation	Scattered throughout South Central Region
Allegheny Mound Ants (<i>Formica exsectoides</i>)	Balsam Fir, Jack and Red Pine.	Trees are declining or dead around ant mounds	Marathon and Portage counties
Armillaria Root Rot (<i>Armillaria mellea</i>)	Various hardwood and conifer spp	Tree decline, leading to possible mortality	Scattered West Central Region
Black Vine Weevil and Strawberry Root Weevil (<i>Otiorhynchus sulcatus</i> and <i>O. ovatus</i>)	Indoor pest problem.	Getting inside buildings and becoming a nuisance. Usually found in the bathroom, kitchen, and occasionally the basement	Scattered West Central Region
Eastern Gray and/or American Red Squirrel (<i>Sciurus carolinensis</i> and/or <i>Tamiasciurus hudsonicus</i>)	Boxelder	Bark stripped off branches and trunk	Clark County

Pest	Host	Damage	Location
Fall Webworm (<i>Hypantria cunea</i>)	Various hardwood species.	Webbing over branches and defoliation	Scattered West Central Region
Lone Star Tick (<i>Amblyomma americanum</i>)	Humans	New specimens brought in for Identification	Chippewa and Eau Claire counties
Multicolored Asian Lady Beetle (<i>Harmonia axyridus</i>)	Indoor pest problem.	Getting inside buildings and becoming a nuisance	Scattered West Central Region
Porcupine (<i>Erthizon dorsatum</i>)	Red Pine	Trunk partially and/or completely girdled, sections of bark stripped off Some trees above the girdle were dead If the trunk was completely girdled, the portion above the girdle kept growing	Portage County
Western Conifer Seed Bug (<i>Leptoglossus occidentalis</i>)	Indoor pest problem.	Getting inside buildings and becoming a nuisance	Marathon County

Oak

Anthracnose (<i>Apiognomonina spp.</i>)	Oak	Browning and curling of infected leaves Premature leaf drop	Scattered throughout South Central & Southeast Regions, Polk, Burnett, Washburn and Sawyer counties: Brown, Outagamie, Winnebago, Waupaca, Waushara, Marquette, Green Lake counties
Botryosphaera canker (<i>Botryosphaeria dothidea</i>)	Northern pin oak	Scattered twig flagging	Burnett, Washburn, Douglas and Bayfield counties
Cynipid Wasps (Family <i>Cynipidae</i>)	Oak	Cosmetic damage	Northwest Region
Eastern Tent Caterpillar (<i>Malacosoma americanum</i>)	Oak	Defoliation : tent in Oak from Adams County	Scattered West Central Region
Forest Tent Caterpillar (<i>Malacosoma disstria</i>)	Oak	Defoliation	Eau Claire County
Jumping oak gall (<i>Neuroterus saltatorius</i>)	White and bur oaks	Seed-like small galls on leaves	Columbia, Dane, and Richland counties
Kermes Scale (<i>Kermes spp.</i>)	Red Oak Saplings	Twig dieback	Juneau County
Oak Apple Gall (<i>Amphibolips confluenta</i>)	Oak	Round gall growing on bottom of leaves	Scattered West Central Region: Walworth County
Oak tatters: Cause unknown	White and bur oaks	Severely tattered leaves and defoliation	Dane and Rock counties: Waupaca County
Oak Timberworm (<i>Arrhenodes minutus</i>)	Oak	Larval galleries degrade lumber quality	Adams and Jackson counties

Pest	Host	Damage	Location
Oak Twig Pruner	red oak	branch tips dropping	Manitowoc, Waupaca, Green Lake, Marquette counties
Oak Webworm (<i>Archips fervidana</i>)	Oak	Leaves webbed together, and defoliated	Scattered West Central Region
Oak Wilt (<i>Ceratocystis fagacearum</i>)	red oak	Many new pockets & major pocket growth	Burnett County, west of Cty F
Tubakia leaf spot (<i>Tubakia dryina</i>)	Oak	Leaf spot and defoliation in late summer	Scattered throughout South Central & Southeast Region, Burett County
Twig Pruner (<i>Elaphidionoides villosus</i>)	Oak	Small branches breaking off and on the ground	Scattered West Central Region
Two-lined Chestnut Borer (<i>Agrilus bilineatus</i>)	Oak	Branch dieback, leading to tree mortality	Scattered West Central Region, Washburn, Douglas ,Columbia, Dane, Rock, Walworth counties

Pine

Annosum root rot (<i>Heterobasidion annosum</i>)	Red Pine	Tree mortality	Columbia, Richland, Sauk, Waushara, and Walworth counties
Armillaria root rot (<i>Armillaria mellea</i>)	Jack, Red, and White Pine	Elevated mortality in 3-15 yr old pines	Burnett, Washburn, Douglas and Bayfield counties
Bark Beetles (<i>Ips spp.</i>)	Jack, Red, and White Pine	Tree mortality Populations building in stressed pines, esp 8-15 yr & >30yr pines	Scattered West Central Region and throughout Northwest Region
Birds	Red and White Pine	Damage to leaders and lateral branches	Scattered West Central Region
Brown Spot Needle Blight (<i>Mycosphaerella dearnessii</i>)	White Pine	Needle discoloration and premature needle loss	Eau Claire County
Diplodia Shoot Blight (<i>Diplodia pinea</i>)	Red Pine Sdlgs	Seedling mortality	Adams, Monroe, and Trempealeau co's
	Jack, Red, and White Pine	New shoot mortality and branch flagging	Scattered West Central Region
		Pockets of high mortality (>50%)	Scattered across Burnett, Washburn & Douglas counties
Dothistroma Needle Blight (<i>Dothistroma pini</i>)	Austrian Pine	thinning foliage	Shawano Co
Eastern& Pine-Pine Gall Rusts (<i>Cronartium quercuum</i> & <i>Endocronartium harknessii</i>)	Jack and Scotch Pine	Galls on branches and trunk, leading to general decline & tree mortality	Scattered West Central Region
European Pine Sawfly	scotch pine	defoliation	Manitowoc Co
Gall Rust (<i>Cronartium quercuum</i> ; <i>Endocronartium harknessii</i>)	jack pine	stem galls and tree mortality	Menominee Co, Northwest region

Pest	Host	Damage	Location
Hail damage/Diplodia canker (<i>Diplodia pinea</i>)	Red and white pines	Branch dieback and mortality	Colombia and Dunn counties
Introduced Pine Sawfly (<i>Diprion similis</i>)	White pine	Defoliation	Manitowoc Co
Jack Pine Budworm (<i>Choristoneura pinus pinus</i>)	Jack, Red, and White Pine	Very light to heavy defoliation of overstory and understory pines, resulting in top dieback and/or tree mortality	Defoliated Red Pine Stands - Adams, Dunn, Eau Claire, Juneau, Oneida, Portage, and Wood counties Defoliated Jack Pine Stands - Adams, Clark, Eau Claire, Jackson, Juneau, Monroe, and Wood Counties
		Light defoliation over 110,000 acres	Polk, Washburn, Burnett, Sawyer, Douglas and Bayfield counties
Northern Pine Weevil (<i>Pissodes nemorensis</i>)	Red pine & white pine seedlings & saplings	Feeding damage, drought, Diplodia Collar Rot, and Pityogenes Bark Beetles cause mortality	Adams and Trempealeau counties - red pine seedlings Marathon and Wood counties - white pine saplings
Pine Bark Adelgid (<i>Pineus strobi</i>)	White Pine Saplings	Needle and branch droop	Dunn County
Pine False Webworm (<i>Acantholyda erythrocephala</i>)	Red Pine	Defoliation	Portage County
Pine Root Collar Weevil (<i>Hylobius radicis</i>)	Scotch Pine & Austrian Pine	Mortality	Brown, Oconto, Manitowoc counties
Pine spittlebug (<i>Aphrophora cribrata</i>)	White pine	Frothy spittlemasses abundant on understory white pines	Kettle Moraine State Forest, Southern Unit, Scattered West Central Region
Pityogenes Beetles (<i>Pityogenes hopkinsi</i>)	White Pine Saplings	Leading to tree mortality, associated with Northern Pine Weevil in trees	Wood County
Red Pine Pocket Mortality	Red Pine	Tree decline leading to tree mortality	Scattered West Central Region, Manitowoc County
Red Pine Sawfly? (<i>Neodiprion nanulus nanulus</i>)	Red Pine	A few trees with defoliated & short needles	Columbia County
Red Pine Shoot Moth (<i>Dioryctria resinosella</i>)	Red Pine	New shoots killed while expanding, causing red shoots on the end of the branches	Scattered West Central Region
	Red & White Pine	Leads to pocket mortality	Door, Shawano, Waupaca counties: Burnett & Washburn counties
	Jack, Red, White Pine	Larval feeding can lead to tree decline and mortality	Scattered West Central Region
White Pine Blister Rust (<i>Cronartium ribicola</i>)	White Pine	Branch cankers, branch flagging, and trunk cankers	Scattered West Central Region: Door, Fond du Lac counties

Pest	Host	Damage	Location
White Pine Cone Beetle (<i>Conophthorus conperda</i>)	White Pine Cones	Boring holes and pitch present on cones that dropped from the trees	Monroe County
White Pine Weevil (<i>Pissodes strobi</i>)	Jack and White Pine	Leader mortality	Scattered West Central Region
Zimmerman Pine Moth (<i>Dioryctria zimmermani</i>)	white pine	mortality	Waushara County

Pine/Fir/Spruce

Spruce Gall Midge (<i>Mayetiola piceae</i>)	Spruce	branch tip mortality	Brown County
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Spruce

Cooley Spruce Gall Adelgid (<i>Adelges cooleyi</i>)	White Spruce	Twig mortality from gall formation	Marathon County
Eastern Spruce Gall Adelgid (<i>Adelges abietis</i>)	White Spruce	Twig mortality from gall formation	La Crosse and Wood counties; Burnett, Washburn & Sawyer counties
Jack Pine Budworm (<i>Choristoneura pinus pinus</i>)	White Spruce	Light defoliation Spruce is next to and under infested red pine	Portage County
Rhizosphaera Needlecast (<i>Rhizosphaera kalkhoffii</i>)	White & blue spruce	Needle discoloration and needle drop	Door, Oconto, & Marathon counties: down in Northwest Region
Spider Mites (<i>Oligonychus ununguis</i>)	White spruce	Needle mottling and needle cast	Dane County
Spruce Bud Scale (<i>Physokermes piceae</i>)	White Spruce	No damage from scale noticed	Marathon County
Spruce Needle Drop -SNEED (<i>Setomelanomma holmii</i>)	white spruce	yellowing and mortality	Manitowoc County
Spruce Spider Mites (<i>Oligonychus ununguis</i>)	Colorado Blue & White Spruce.	Needle discoloration	Scattered West Central Region

Tamarack

Eastern larch beetle (<i>Dendroctonus simplex</i>)	Tamarack	mortality	Outagamie, Marinette counties: Northwest & North Central regions
Larch Casebearer (<i>Coleophora laricella</i>)	Tamarack	Defoliation	Marathon, Monroe, and Wood counties
Spruce Spider Mites (<i>Oligonychus ununguis</i>)	Tamarack	Needle discoloration	Wood County

Special Reports

Jack Pine Budworm (*Choristoneura pinus pinus*)

Survey Procedures and Results: 2006

Shane Weber, DNR Forest Entomologist
Dept of Natural Resources
Spooner, Wisconsin

Early larval survey

This survey is done on a yearly basis and is a key indicator of the presence of destructive budworm populations. Thirty shoots and staminate flowers that can be reached from the ground are checked for larvae. Since staminate flowers are often scarce, a majority of shoots are usually used. A high plot, considered sufficient to cause moderate to severe defoliation, is defined as any plot with a count of 10 or more infested shoots and flowers.

Early Larval Populations

County	No. Plots	No. Infected Shoots	Infected Shoots/Plots	No. High* Plots	% High Plots
Polk	15	113	7.53	4	26.7
Burnett	24	154	6.42	6	25.0
Washburn	21	171	8.14	8	38.1
Douglas	54	466	8.63	21	38.9
Bayfield	32	400	12.50	22	68.8
District	146	1,304	8.93	61	41.8

*High plots are defined as any one plot which contains 10 or more infested shoots or flowers

Early Larval Population Trend: 2006

County	No. Infested Shoots/Plot						% High Plots				
	2002	2003	2004	2005	2006	Change 2005-2006	2002	2003	2004	2005	2006
Polk	0.60	0.13	0.93	3.87	7.53	+95%	0	0	0	6.7	26.7
Burnett	0.63	0.71	0.67	5.08	6.42	+26%	0	4.2	0	25.0	25.0
Washburn	0.52	0.19	0.86	9.14	8.14	-11%	0	0	0	52.4	38.1
Douglas	0.35	0.48	1.78	11.39	8.63	-24%	0	0	0	53.7	38.9
Bayfield	0.16	0.59	2.25	16.38	12.50	-24%	0	0	0	78.1	68.8
District	0.40	0.47	1.48	10.35	8.93	-14%	0	0.7	0	49.3	41.8

Jack Pine Budworm Pupal Survey

This survey is also conducted annually and gives a good indication of the kinds and numbers of pupal parasites in the population as well as next year's population of jack pine budworm. It is done in July when most insects are in the pupal stage. Some adults may already have emerged, but empty pupal cases are collected and counted as emerged moths. At each stop, pupae are collected on a time basis. If five pupae are not found in five minutes, the collection is terminated. If five pupae are found in 5 minutes or less, the collection is continued until 25 pupae are found or until 15 minutes have elapsed. The time required to find 25 pupae is then recorded. Adults, parasites and non-emergence are recorded for each pupae.

2006 Pupal Survey

County	Total Pupae	Total Minutes	Pupae/Min	Moths		Parasites		Not Emerged	
				No.	%	No.	%	No.	%
Polk	168	131	1.28	68	40.5	89	53.0	11	6.5
Burnett	346	200	1.73	164	47.4	149	43.1	33	9.5
Washburn	296	190	1.56	142	48.0	121	40.9	33	11.1
Douglas	818	501	1.63	415	50.7	329	40.2	74	9.1
Bayfield	639	307	2.08	353	55.2	220	34.4	66	10.4
District	2,267	1,329	1.71	1,142	50.4	908	40.1	217	9.5

Pupal Population Trends

County	2003 Pupae/min	2004 Pupae/min	2005 Pupae/min	2006 Pupae/min	%Change 2005-2006
Polk	0.11	0.67	1.34	1.28	-4.5
Burnett	0.53	0.93	1.26	1.73	+37.3
Washburn	0.52	1.1	2.28	1.56	-31.6
Douglas	0.51	1.48	2.21	1.63	-26.2
Bayfield	0.49	1.38	2.41	2.08	-13.7
District	0.48	1.26	2.06	1.71	-17.0

Jack Pine Budworm Parasite and Predator Complex

This survey involves a careful examination of all the budworm pupae collected which do not produce moths. Adult specimens are compared to a reference collection. Any unknown adults are sent to the University of Wisconsin for identification. Pupal cases from which nothing emerges are dissected to ascertain the cause of failure.

Parasite/ Predators	Polk	Burnett	Washburn	Douglas	Bayfield	Total	% of Parasitized	% of Total
Itoplectes	52	74	72	176	72	446	49.1	19.7
Scambus	4	6	4	12	8	34	3.7	1.5
Phaogenes	1	6	13	10	11	41	4.5	1.8
Pteromalids	1	2	2	5	31	41	4.5	1.8
Tachinids	8	19	9	48	33	117	12.9	5.2
Predators	23	42	21	78	65	229	25.2	10.1
Total	89	149	121	329	220	908	100	40.1

Invasive plants are non-native species that become established in natural plant communities and wild areas, replacing native vegetation. When a plant species is introduced to a new area, it is no longer regulated by the insects, fungi, disease, grazing, or competition that controlled its population in its native habitat. While most horticultural plants can not survive Wisconsin's climate, and thus do not become invasive, the absence of natural enemies allows some introduced plants to out-compete native vegetation and become problem species. Allowing these pests to spread unchecked has serious consequences for the ecological and economic health of Wisconsin forests.

During the spring, summer, and fall of 2006 the Wisconsin Department of Natural Resources Division of Forestry coordinated a survey of invasive plant species on priority sites in Wisconsin's northern State Forests for the purpose of collecting information on the ecology of invasive plants, mapping the current existence and extent of invasive plant infestations within the state forests, establishing a baseline GIS database to aid in the development of invasive plant management goals and objectives, increasing departmental and public awareness of invasive plant issues, and creating support for management and prevention programs. Results contained in this report are from surveys conducted in the Black River SF, the Brule River SF, the Flambeau River SF, the Governor Knowles SF, the Northern Highland-American Legion SF, and the Peshtigo River SF. The northern and southern units of the Kettle Moraine State Forest were surveyed in a separate effort. Invasive plants are found throughout Wisconsin, but very little information exists on their status in state forests, in particular those forests in the northern areas of the state.

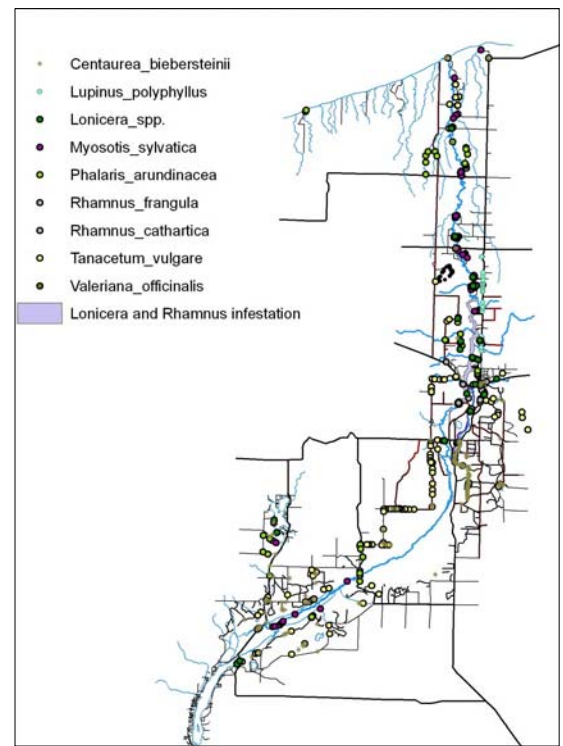
Each State Forest identified a list of priority search areas for invasive plant surveys. Priority areas include corridors along roads and trails, homesteads, boat landings, river ways, timber sales, gravel pits, recreational sites and campgrounds. Survey crews used maps and other available information to identify priority areas within each forest, and developed a survey schedule for these areas based on phenology. Priority areas were surveyed in as close to their entirety as was feasible to avoid gaps that could result in undiscovered populations and affect subsequent management decisions. Surveys were conducted on foot, or by bicycle, motorized vehicle, or canoe/kayak.

The survey results provide information about the extent of several species that are of great concern in Wisconsin's forests. These plants are causing serious ecological damage to significant areas of the upper Midwest. While not all of these plants are widespread in Wisconsin, they spread aggressively and can become problematic if allowed to spread.

Survey crews recorded over 5,000 observations of 114 species of invasive/non-native plants in the state forests. Eleven species or groups of species accounted for 78% of these observations: spotted knapweed, non-native thistles, Eurasian honeysuckles, reed canary grass, common St. John's-wort, common tansy, buckthorn species, garden valerian, butter-and-eggs, forget-me-nots, and sheep sorrel. The location of each observation was recorded using GPS technology, and will be compiled in an invasive plant GIS database. Detailed reports are being prepared for each forest, along with a report detailing the overall results of the survey.

To obtain copies of invasive plant reports or data files please contact:

Sarah Herrick: Sarah.Herrick@dnr.state.wi.us (608)267-7689



Map of common invasives in the Brule River State Forest

Invasive Species of Great Concern

Garlic Mustard (*Alliaria petiolata*)

The shade tolerant herb garlic mustard is a serious invader of forest understories in southern Wisconsin; however, survey results indicate that it is not yet widespread in the northern State Forests. Small populations were found along trails and in campground in Northern Highland, Governor Knowles, Flambeau River, and Black River State Forests. Control measures have already begun in these areas to ensure that these populations do not spread, and become a problem. Garlic mustard is thus far absent from the Brule River and Peshtigo River State Forests.



Garlic mustard along a trail in the Governor Knowles State Forest

Buckthorn in the Black River State Forest

Non-native honeysuckles (*Lonicera* spp.) and buckthorns (*Rhamnus* spp.) are among the most widespread invaders of forest understories. Survey crews located relatively large populations of these species in and around campgrounds, boat landings, and trails in all six of the surveyed forests. Results also indicate many areas where buckthorn and honeysuckle are not present. Preventing the spread of these pests into new areas should be a top priority. Other invasive shrubs and small trees like Japanese barberry and black locust are present in one or more of the forests, but are uncommon, and not widespread.



Buckthorn in the Black River State Forest

Reed Canary Grass (*Phalaris arundinacea*)

This cool season grass is a serious invader of open and forested wetlands and moist uplands in Wisconsin. Survey results indicate it is widespread in all of the state forests, and among the species most commonly observed during the survey. It was most often observed in low areas along trails and roads.



Reed canary grass in the Flambeau River State Forest

Common Reed Grass (*Phragmites australis*)

This warm-season grass is a major problem in wetlands and shorelines in eastern Wisconsin. Survey results indicate that it is not widespread on state forest land, though a few small populations were present in wetter areas within the Governor Knowles and Brule River Forests. This species may be out-competed by the much more pervasive reed canary grass, but populations should be monitored to in case they begin to spread.

Spotted Knapweed (*Centaurea biebersteinii*)

Spotted knapweed was the most commonly observed invasive species on State Forest land. It is widespread in open areas, and while it doesn't pose a significant threat to forested habitats, it severely reduces grassland biodiversity, and quickly invades following disturbance. Large populations were present in all six of the surveyed forests.

Leafy Spurge (*Euphorbia esula*)

Leafy spurge is present in four of the six forests included in this survey. However, it is only common in the Peshtigo River State Forest where it is a pervasive invader, dominating most open areas within the forest. Thus far nothing has been done to control the species, and at this point it will require a substantial effort to control the population.



Spotted Knapweed in the Governor Knowles State Forest

Using multi-temporal satellite imagery

Sally Dahir, DNR forest health analyst, Fitchburg, WI

Emerald ash borer is predicted to arrive in Wisconsin some time in the near future. Where this is likely to occur initially and what the best response strategy might be depends on accurate knowledge of where ash occurs in the state and at what density. Until the emergence of satellite imaging, we had no way to predict this, especially at a scale that might be useful to land managers. Landsat imagery has been used in the past, to map broad landuse categories such as agricultural lands, coniferous forests, and wetlands but, to date, has not been practical in delineating more specific forest types.

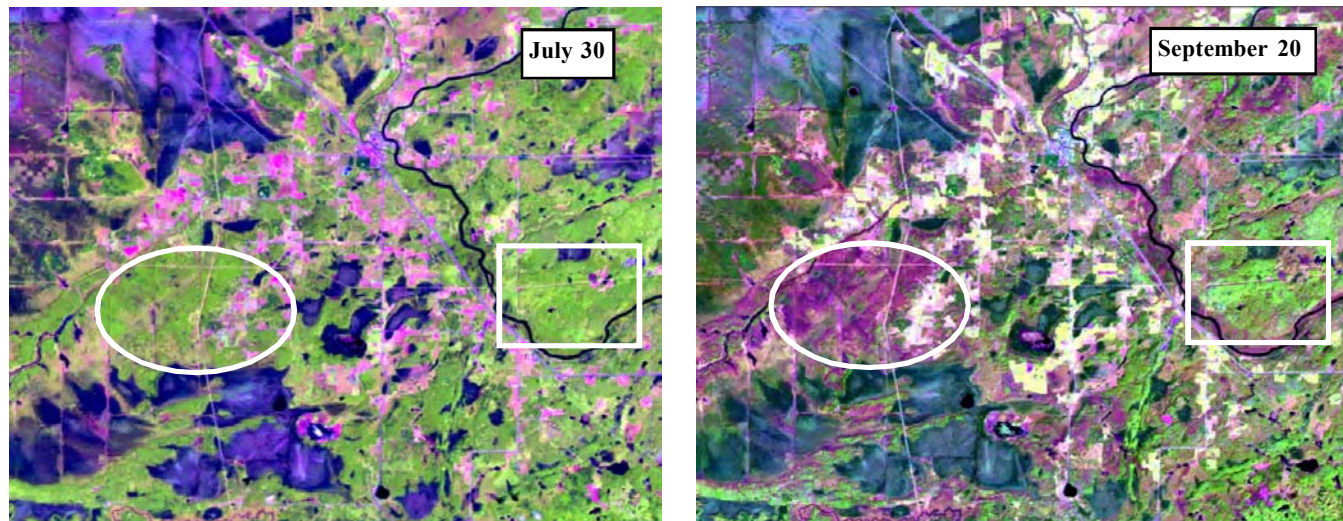


Figure 1 . The satellite image on the left was taken during the summer when all deciduous trees are green and reflect strongly in the near-infrared, represented by the color green. The image on the right was taken on September 20th when the ash (within the white circle) had lost its leaves but other deciduous trees (within the white rectangle) had not. You can see the change in reflectance (images provided by Peter Wolter).

Professor Phil Townsend of the University of Wisconsin Dept. of Forest Ecology and Management, however, has been successful in mapping ash species with a high degree of accuracy based on the differing phenology of this genus (Townsend and Walsh, 2001*). For instance, ash will leaf out later in the spring and lose its leaves earlier in the fall than other tree species in mixed deciduous and lowland forests. By comparing images taken at different times during the growing season (Figure 1), you can distinguish between areas where foliage was present in the summer but absent in early fall (indicating high densities of ash), and areas that retain their foliage, (indicating very low ash densities).

Green healthy foliage reflects highly in the near infrared reflectance bands and absorbs strongly in the red band. Therefore, a high ratio of infrared to red reflectance would indicate healthy green foliage and a lower ratio would indicate unhealthy or defoliating crowns. In addition, ash species, with the exception of black ash in lowland areas, occurs only sporadically in the forest and therefore, will make up only a portion of a 30m Landsat pixel. However, the pattern of reflectance of that pixel will be different than a pixel with no ash; infrared reflectance decreasing as the proportion of defoliated ash increases. To illustrate, Figure 2 shows a fall image of a deciduous forest in Potawatomi State Park, Door County, in which the defoliating ash crowns stand out clearly from the surrounding leafy crowns. Figure 3 shows the same image with an overlay of what a Landsat image of the area might look like. The correspond-

* Townsend, P.A. and S.J. Walsh. 2001. Remote sensing of forested wetlands: application of multitemporal and multipectral satellite imagery to determine community composition and structure in Southeastern USA. *Plant Ecology* 157:129-149.



Figure 2. Defoliated ash crowns appear purplish in this photo of the Potawatomi State Park.

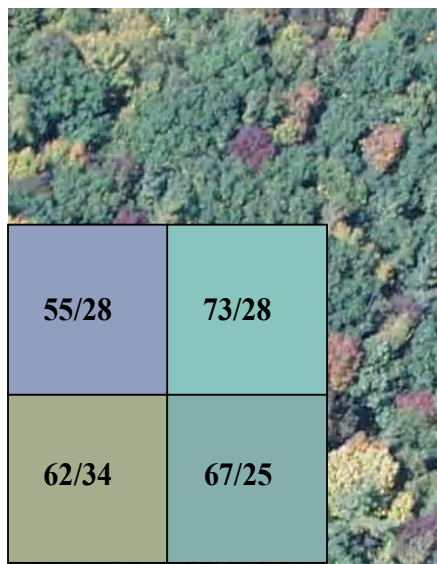
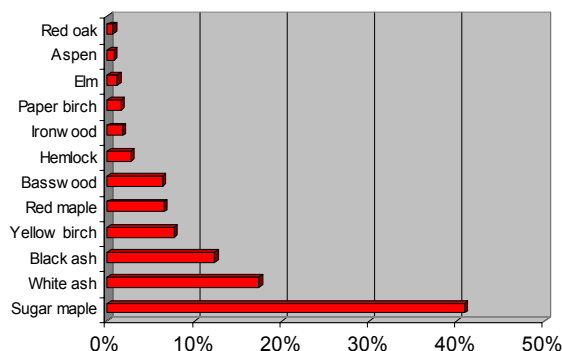
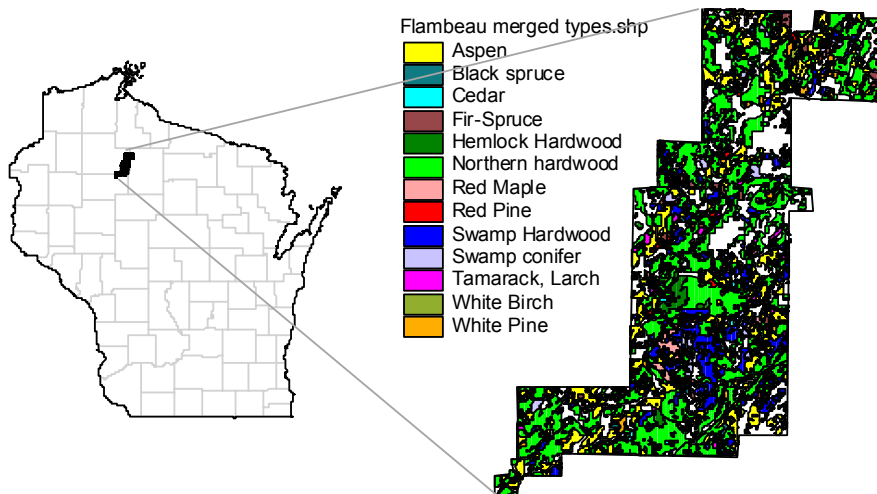


Figure 3. Same image with overlay of Landsat pixels showing infrared to red ratio for each pixel.



Figure 4. Flambeau River State Forest with plots showing percentage of ash.

ing ratios of infrared to red are shown for each pixel. Note that the infrared reflectance is higher for the greener appearing pixels. Because Landsat satellites record images about every 16 days, it is possible to capture images in which ash is defoliated and other species are still green as well as dates in which all trees have healthy green crowns (ie. midsummer). By comparing these images with knowledge of the density of ash in a particular stand, one can derive a formula for predicting ash density which can be applied to all the pixels in an image and then extrapolated to a larger area. Accurate ground truthing is essential to this process.



Percent basal area by species

In a pilot study in 2006, we surveyed northern hardwood stands in the Flambeau River State forest (see Figure 4 and map above) to determine the overall proportion of ash. Accurate GPS coordinates were taken and the basal area of ash and other species was recorded (see chart on left). Figure 4 above shows some of these points and the corresponding percentages of ash basal area. Further ground work and satellite interpretation will be carried out, if funding becomes available.